A HISTORY OF ENTOMOLOGY

BY THE SAME AUTHOR

Injurious and Beneficial Insects of California

Insects of Western North America

A HISTORY
OF
ENTOMOLOGY

BY
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PREFACE

The history of the development of entomology in any country is so encompassed by the history of the peoples and the growth of the industries of a region that all must be studied together to arrive at any valuable conclusions. The history of this science in America may be divided into periods of Indian occupation, discovery, exploration, settlement, and exploitation, prior to the establishment of permanent homes and industries. America, with its vast areas of mineral, forest, and agricultural domain, variable climate, and extensive sea coasts with many splendid harbors, was from the very beginning destined to a most interesting and remarkable development. Outside influences are particularly noticeable in the development of agriculture, which industry is most closely related to our study of entomology. In all the vast regions of this great empire, before the advent of the Europeans, there existed only fragments of a more or less specialized type of native agriculture among the Indians of the Eastern and Southern States, but there was no such development in the region along the Pacific Coast. Aside from the production of corn, beans, and squashes, it was necessary to create an entirely new agriculture and North America rapidly became, and still is, perhaps the most gigantic experiment station in the world. The Spanish introduced plants and animals from the temperate, tropical, and subtropical regions of the vast Spanish domains. The English, and others from northern Europe brought seeds of cereals, vegetables, herbs, flowers, forage crops, and plants from their respective countries, while the gaps were supplied by the emigrant representatives from all other parts of the world. As a result of these influences we now produce most of the major crops of the entire world with the exception of the more strictly tropical ones.

The relations of entomology to this program are most interesting. Native species of insects were and still are numerous in this country. The transformation of the wild lands to agricultural uses has forced a large number of these indigenous forms to move over on to the introduced crops and not a few have become pests. However, many of the most important economic insects, whether in-

jurious or beneficial, have, like the hosts upon which they subsist, been introduced from the four corners of the earth. Some of these, such as the gypsy and brown-tail moths, cotton boll weevil, Japanese beetle, European corn borer, cottony cushion scale, pear thrips, San José scale, and a host of others, were apparently of little consequence until they were transplanted to our shores. To meet the increasing entomological problems the farmers turned their faces toward the newly established Division of Entomology and the agricultural colleges and experiment stations where this science had rapidly developed to a remarkable degree and from which agriculturists sought the solution of special problems which were known nowhere else. A demand for local entomological investigations was immediate and the response was entirely adequate. To trace such progress is the chief object of this volume.

The viewpoint of the book is obviously Western, but this may be partly excused on the grounds that the work was originally intended to embrace only Western entomology and partly because the historical development of the science is much less known in the West than in the other parts of the country.

There is much additional information that could be added to this volume and the author fully realizes the many shortcomings of his work. It is hoped, however, that the fragments of history, which are becoming more obscure as time moves on, may in the future, if not in the present, prove helpful to students of the historical aspects of the subject.

The preparation of the manuscript has been both arduous and meticulous and has necessitated so many revisions that one is impressed with the imperfectness of supposed historical facts. Some of the illustrations have purposely been taken from older works to show a characteristic early scene or to represent the art of the illustrators of the time. A number of new photographs, made by W. C. Matthews and drawings by Miss D. G. Harris, add materially to the interest and value of the work. The author appreciates the interest and coöperation of many entomologists, named elsewhere, who have read portions of the manuscript, made helpful suggestions, and furnished specimens, photographs, and bibliographical and biographical data.

E. O. E.

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CHAPTER I

PREHISTORIC ENTOMOLOGY

Pleistocene Insects from Asphalt Pits in California

Until 1929 the only deposits of fossil insects so far discovered in California occur in the Pleistocene [1] or Quaternary asphalt pits at

Fig. 1.—The Hancock Ranch house and the lagoon at the Rancho La Brea. The first prehistoric animal remains were found at the edge of the lagoon near this house. (Photograph from negative loaned by the Department of Paleontology, University of California.)

the Rancho La Brea in Los Angeles, at McKittrick in Kern County, and at Carpinteria, Santa Barbara County. From the former,

[1] The age of these deposits is only to be conjectured. Paleontologists believe that they occur in the lower or the middle, but not in the upper Pleistocene. In our method of reckoning time they should be referred to as perhaps hundreds of thousands of years old rather than millions of years old. The disappearance of the mammals and birds, which occur in such numbers in these deposits, is due to ex-

Fig. 2.—General view of the Rancho La Brea before excavations began. Exposed and weathered bones may be noted in the original matrix. (Photograph from negative loaned by the Department of Paleontology, University of California.)

Fig. 3.—University of California excavations at Locality 2051, Rancho La Brea, showing animal remains *in situ*. Insects were found along with the other material. (Photograph from negative loaned by the Department of Paleontology, University of California.)

great numbers of Coleoptera chiefly of the family Tenebrionidæ are found although some Carabidæ and Dytiscidæ also occur there. They are deposited in sticky asphaltum and are often lodged about the bones of mammals, the bodies being usually disjointed with the head and prothorax separated from the abdomen and elytra.

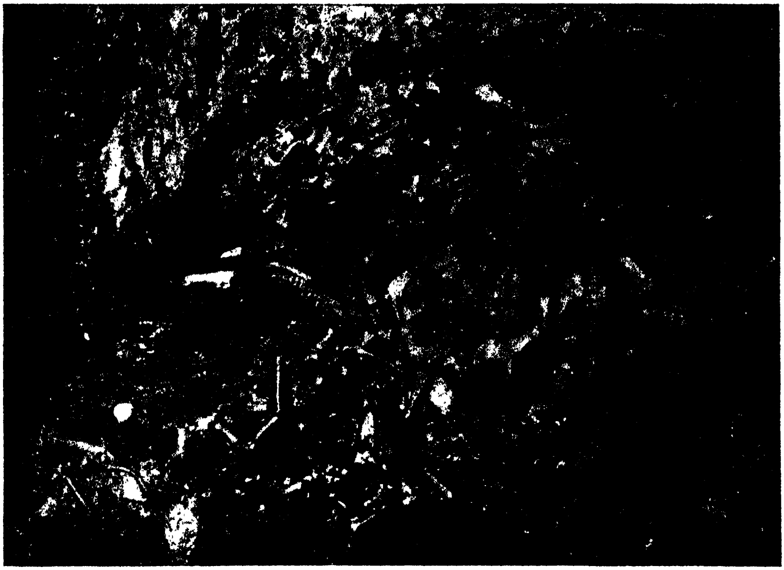

FIG. 4.—A close view of the animal remains at the bottom of the pit at Locality 2051 shown in Fig. 3. (Photograph from negative loaned by the Department of Paleontology, University of California.)

The Coleoptera occurring at McKittrick are chiefly water beetles of the families Dytiscidæ and Hydrophilidæ, but there are also present large numbers of dragonflies or Odonata. The asphaltum is very crumbly and easily broken, and, while the beetles may be recovered in almost perfect condition, it is impossible to remove the frail dragonflies.

La Brea Pits (Figs. 1–8)

Fordyce Grinnell [2] wrote a paper on some Coleoptera taken at Rosmary (La Brea) in which the following species were listed or described:

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tinction, rather than evolutionary changes. The insects represented, however, survived and are either identical with or closely allied to present day species.

[2] *Quaternary myriapods and insects*, Univ. of Calif. Pub., Geology, vol. 5, pp. 207–215, pls. 15–16 (1908).

CARABIDÆ.

Platynus funebris Leconte (single elytron).
Amara insignis Dejean (two perfect elytra).
Pterostichus sp. (several elytra).
Calosoma semilaeve Leconte (elytron).

FIG. 5.—Crude oil pool at the Rancho La Brea showing two dead birds trapped and illustrating the probable manner in which animals were caught in prehistoric times. (Photograph from negative loaned by the Department of Paleontology, University of California.)

FIG. 6.—The corroded remains of beetles and bones of small mammals as removed from the asphalt deposits at the Rancho La Brea.

DYTISCIDÆ.

Dytiscus marginicollis Leconte (two elytra).

TENEBRIONIDÆ.

Coniontis robusta Horn (one elytron).
abdominalis Leconte (two well-preserved specimens).
puncticollis Leconte (portion of an elytron).
elliptica Casey (thorax and elytra).
Eleodes acuticauda Leconte (many specimens).
behri Grinnell (perfect specimen).
consobrina Leconte (abdomen and elytra).
laticollis Leconte (number of good specimens).
intemedia Grinnell (complete abdomen and elytra).
elongata Grinnell (single elytron).

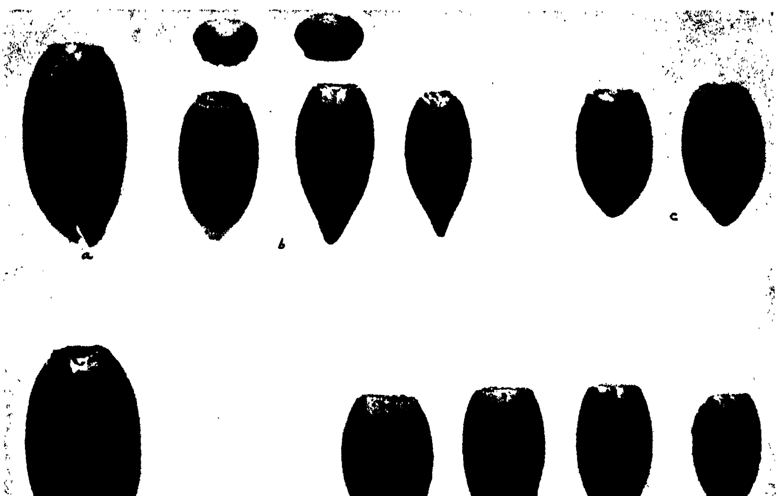

FIG. 7.—The remains of tenebrionid beetles collected in the asphalt deposits at the Rancho La Brea. *a*, *Eleodes laticollis* Lec.; *b*, *E. acuticauda* Lec.; *c*, *E. omissa* Lec.; *d*, *E. grandicollis* Mann.; *e*, *E. distans* Blaisd. (?).

This paper by Grinnell was reviewed by Blaisdell [3] who gave the following synonymy of the new species:

Eleodes elongata Grinnell is a synonym of *E. grandicollis* Esch.
behri Grinnell is a synonym of *E. parvicollis* Esch.
intermedia Grinnell is a synonym of *E. parvicollis* Esch.

[3] Blaisdell, F. E., *Revision of Eleodiini*, U. S. Nat. Mus., Bul. 63, pp. 505–508 (1909) (Appendix).

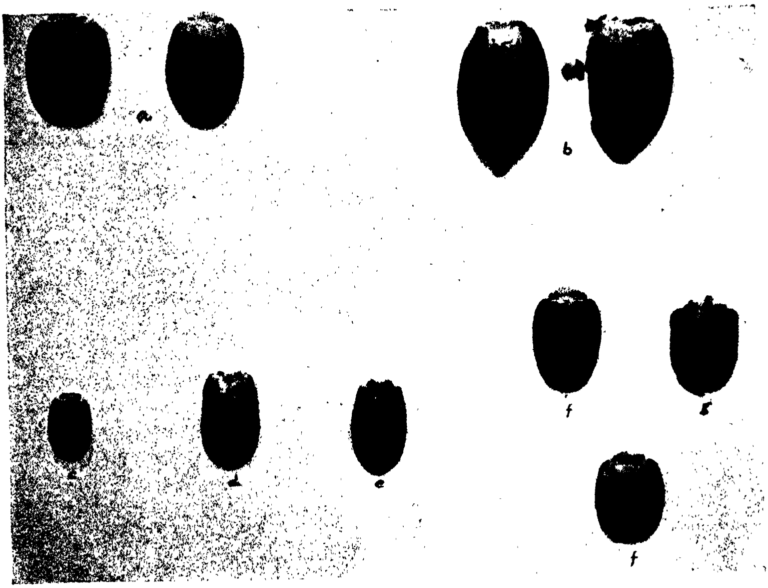

Fig. 8.—Beetle remains taken in the asphalt deposits of the Rancho La Brea pits. *a*, *Cratidus osculans* Lec.; *b*, *Eleodes omissa* Lec.; *c*, *Eulabis* (probably *laticornis* Casey); *d*, *Pterostichus* (*vicinus* Mann.?); *e*, *Nyctoporis carinata* Lec.; *f*, *Eleodes* sp.; *g*, *Coniontis* sp.

Fig. 9.—A general view of the asphalt deposits at McKittrick, California. (This photograph, furnished by E. L. Furlong, was taken by him in 1926.)

I have had an opportunity to examine a large number of insect remains from the asphalt pits of La Brea and also from McKittrick and with the aid of E. C. Van Dyke and F. E. Blaisdell, who made the determinations, have listed the insects cited below.

A large number of beetles which were examined by the writer in 1928, were taken from the pleistocene mammal remains embedded in asphalt at La Brea. By far the commonest species in the material examined is the sharp-tailed eleodes, *Eleodes acuti-*

FIG. 10.—The asphalt deposits at McKittrick from which the insect remains were taken in 1926. (Photograph taken in 1926 by E. L. Furlong.)

cauda Leconte and the large form *laticollis* Lec. Specimens varied in size (elytral measurements) from 15 to 22 mm. The species examined were:

TENEBRIONIDÆ.

Eleodes acuticauda Leconte (many specimens).
laticollis Leconte (many specimens).
omissa Leconte (many specimens).
(*distans* Blaisdell?) (many specimens).
grandicollis Mann. (one specimen).
Eleodes sp. (small species, two specimens cleaned).
Coniontis sp. (one specimen).
Cratidus osculans Leconte (two specimens cleaned).
Nyctoporis carinata Leconte (one specimen cleaned).
Eulabis sp. (probably *laticornis* Casey) (one specimen cleaned).

CARABIDÆ.

Pterostichus sp. (one specimen cleaned).

McKittrick Pits (Figs. 9–13)

The material from McKittrick is very much richer in kinds of insects, especially aquatic, than that of La Brea. It is a dry, crumbly, oily, soil-like material in which the insects are embedded in masses, but from which only the Coleoptera can be removed for study. Large dragonflies (Anisoptera) are very abundant, but so frail that only the heads are removable intact. Of the Coleoptera,

FIG. 11.—A matrix of dragonflies and water beetles in the loose asphaltum from the McKittrick pits. The water beetles are: *Hydrous triangularis* (Say), dorsal view, and *Cybister explanatus* Lec.

water beetles are most numerous, but there are also ground beetles and possibly others which are not yet exposed. The giant water scavenger, *Hydrous triangularis* (Say), and the predacious water beetle, *Cybister explanatus* Leconte, are very abundant and can be removed intact with the loss of only the appendages. A small single specimen of *Hydrophilus* sp. was also removed. From the exterior appearance of the deposits (Fig. 11) it is expected that many more species will be revealed when E. C. Van Dyke and F. E. Blaisdell work up this material in the near future. I am greatly indebted to Dr. Eustace L. Furlong, formerly Curator of

the Vertebrate Collection, Museum of Paleontology, University of California, for the use of these insects which he personally took from the oil pits and under whose care they were, as well as for the

FIG. 12.—Adult specimens of the giant water scavenger, *Hydrous triangularis* (Say), taken from the asphalt deposits at McKittrick, California, by E. L. Furlong in 1926. This species is still one of the commonest water beetles in California.

use of negatives of the La Brea and McKittrick asphalt pits, from which the accompanying splendid photographs were made.

FIG. 13.—Almost perfect specimens of the predacious water beetle, *Cybister explanatus* Lec., taken from the asphalt deposits at McKittrick by E. L. Furlong in 1926. This species is now abundant in the same general region.

Carpinteria Pit [4]

In May, 1927 a large number of insects were taken along with the rare plant material in some asphalt deposits along the ocean

[4] Hoffman, R., *The finding of Pleistocene material in an asphalt pit at Carpinteria, California*, Science, vol. 66, p. 155 (1927). Stock, C., *Pleistocene fauna and flora,*

near Carpinteria, California. A quantity of these was taken by R. W. Chaney, who turned portions over to E. C. Van Dyke for study, but no report has as yet been made concerning them. In general they appear to be much like those taken in the La Brea pits.

EOCENE INSECTS IN CALIFORNIA

In 1929 Ralph W. Chaney, of the Museum of Paleontology, University of California, collected a portion of a fossil dragonfly

FIG. 14.—The central portion of the wing of a fossil dragonfly, *Protothore explicata* Ckll., collected in the Eocene of Shasta County, the first true fossil insect named from California. (Photograph of the type specimen furnished by Professor Cockerell and now on deposit in the Museum of Paleontology, University of California.)

wing with fossil plants in soft bluish rock of the Eocene, at Phillips' sawmill, five miles south of Montgomery Creek, Shasta County, California. The specimen (Fig. 14) was described as *Protothore explicata* by Cockerell [5] and represents a new genus and a new species. This is the first true fossil insect ever described from California.

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ibid., pp. 155–156. Miller, L., *Bird remains*, *ibid.*, p. 156. Chaney, R. W., and Mason, H. L., *Fossil plants*, *ibid.*, pp. 156–157.

[5] Cockerell, T. D. A., *A fossil dragon-fly from California* (*Odonata: Calopterygidae*), Entom. News, vol. 41, pp. 49–50, pl. vi (1930).

Bruce L. Clark of the Department of Paleontology, University of California, informs me that he saw the remains of a fossil insect taken in the Eocene shales of Mount Diablo, California, a number of years ago. The specimen was taken by another person and apparently has not yet reached the hands of the insect paleontologists.

CHAPTER II

CALIFORNIA INDIANS IN RELATION TO ENTOMOLOGY

Culture in the modern sense was unknown to the California Indians. Everything they did had to do with the real or the supposed necessities of life. Food was the most important item in the regular routine and required a large share of their time. The driving out of diseases and the fulfillment of certain religious rites received much attention, but very little was given to cleanliness and sports. While not differing greatly in these respects from the Indians of the eastern and southern United States, there is much to be said as to the manner in which the necessities of life were provided. The Californians were much more isolated than other Indians, being separated from other tribes by high mountains, deserts, rivers, and other geographical barriers. Although they inhabited a country unsurpassed in climate and agricultural possibilities they developed an unusually low plane of civilization and it is probable that the mild climate and the great abundance of native plant and animal food are responsible for the easy way in which they viewed life. There were many lazy and indifferent tribes, but there were also strong and capable peoples who could cope with all of the adversities in nature about them.

The native population in California, during the early mission days, was sparse and although greatly exaggerated by some historians really amounted to only about 133,000 persons according to Chas. E. Chapman.[1] Of these approximately 70,000 lived between San Francisco and San Diego.

In referring to their attainments Chapman states:[2] "Ethnologically California may be said to be characterized by the absence of agriculture and of pottery." Of these agriculture was the more neglected. In introducing the question of their food habits I cannot refrain from quoting further from this same author.[3]

[1] Chapman, C. E., *A history of California: The Spanish period* (N. Y., Macmillan, 1921), p. 12.

[2] *Ibid.*, p. 13.

[3] *Ibid.*, pp. 14–15.

"Those who hold that food is the mainspring of human activities will not be loth to admit that the diet of the Californians left much to be desired. They ate very little meat, because they lacked domestic animals and were so bestially lazy, especially in central and southern California, that they were poor hunters. Nevertheless, they were far from being vegetarians. On the contrary they ate nearly everything that teeth could bite which came their way. Coyotes, crows, lizards, rats, mice, frogs (and not merely the hind legs), skunks, and snakes were eaten by many groups and when a dead whale drifted ashore it provided occasion for rejoicing because of the meat it supplied. *Grasshoppers were something of a delicacy. They were eaten in various forms, dried, mashed, or roasted.* Many of the Indians caught fish but many others, even of those who dwelt along the coast, confined themselves to taking salmon and lamprey eels in the rivers. Bear meat and the flesh of other large game were rarely eaten, not that the Indians objected to the taste, but because they believed that such dangerous creatures must be possessed of a demon and to eat the meat would mean swallowing the demon. The 'rough delicacies' thus far named were not, however, the principal food supply of the Californians; otherwise, there would have been no Californians left to greet the white man. The Indians lived chiefly on foods that grew wild. Of these, acorns were easily the most important item. They were ground to a flour and cooked to make a bread. Many wars were fought in primitive California over the possession of acorn groves. Next after acorns came seeds, especially of grasses and herbs. Roots and berries were also used. The soil was left untilled, for to the natives the land seemed bountiful enough as it was. In a word, then, the Californians ate little more than that which came easily to hand without effort. It is hardly necessary to observe that a country with no better food supply than that just described would be little better than a barren desert to the white man coming from afar to make settlements."

In speaking of their food, A. L. Kroeber, eminent California authority on Indians, states: "California Indians are perhaps the most omnivorous group of tribes on the continent." [4]

Ethnological studies have shown that the Indian was a keen student of nature. Inasmuch as about four-fifths of his diet was vegetable it is a credit to him that he had an exact knowledge of the different plants and animals, even to species and varieties. Every-

[4] *Handbook of Indians of California*, Bur. Am. Ethnology, Bul. 78, p. 523 (1925).

thing had a separate name and it was a real educational feat to acquire this amount of knowledge by word of mouth. There are many detailed lists of the plants utilized by different tribes.[5]

The acorns of the white oaks were the favorite with most tribes and those of the black oaks were second choice. The acorns of the tan oak, *Lithocarpus densiflora* (H. & A.), were preferred by the Yurok and other northwestern tribes, while in other places those of the coast live oak, *Quercus agrifolia* Nee; the canyon oak, *Q. chrysolepis* Liebm.; the interior live oak, *Q. wislizenii* A. DC.; and the Oregon oak, *Q. garryana* Dougl., were favored, while those of the valley oak, *Quercus lobata* Nee; the mesa oak, *Q. engelmanni* Green; the blue oak, *Q. douglasi* H. & A.; the California black oak, *Q. kelloggi* Newb.; and even those of the scrub oak, *Q. dumosa* Nutt.; and the huckleberry oak, *Q. vaccinifolia* Engelm., were used when necessity demanded. Oaks were absent in some of the inhabited areas, but the acorns were not difficult to reach. They were also frequently purchased from other tribes. In some cases the acorns were immediately dried, hulled, crushed to a meal, leached and then stored for future use and for trade. They were also stored in baskets or in rude caches or granaries (Fig. 15) constructed for this purpose. The latter were so open that the squirrels often took freely from the stores and they were subject constantly to the attacks of insects. It is apparently not known whether the Indians considered the addition of caterpillars and grubs as desirable or undesirable when crushed with the acorns, but it is not likely that these fatty larvæ were in any way offensive. Acorns of the live oaks were often buried in the wet mud or immersed in water for an indefinite period until they turned black. This was done to leach out the tannin after which the acorns were cooked whole or roasted in the ashes. Another method was to hull the acorns, remove the exterior skin, store them in baskets and allow to mildew. They were then placed in a hole in the sand in the rivers and left until they turned black when they were ready for roasting. These two methods were also of great value in preserving the acorns from the attacks of insects, but it is doubtful if the Indians even thought of such a thing.

Next to acorns, pine nuts were the most important food, and among the Koso, Panamint or Paiute Indians the nuts of the one-leaf piñon, *Pinus cembroides* Zucc. var. *monophylla* Voss., were the most important. Those of the Parry piñon, *P. cembroides* Zucc. var. *parryana* Voss., were used in southern California, while the Indians of middle and northern California frequently gathered the nuts of the digger pine, *P. sabiniana* Dougl. The seeds of other pines were also used. When hard pressed for food the seeds of the buckeye,

[5] Powers, Stephen, *Contrib. to N. Am. ethnology*, U. S. Geog. & Geol. Surv. of Rocky Mt. Region, Dept. Interior, Washington, D. C., p. 431 (1877).

Kroeber, A. L., *Handbook of Indians of California*, Bur. Am. Ethn., Bul. 78, pp. 649, 694–696 (1925).

Barrows, D. P., *The ethno-botany of the Coahuilla Indians of S. Calif.* (Univ. of Chicago, 1900).

Coville, F. V., *Notes on plants used by the Klamath Indians of Oregon*, U. S. Nat. Herbarium, Contr., Washington, D. C., vol. 5, no. 2 (1897).

Palmer, Edward, *Plants used by the Indians of the U. S.*, Amer. Nat., vol. 12, pp. 593–606, 646–655 (1878).

Æsculus californicus (Spach), were dried, ground, leached and used as a substitute for acorn meal. Nuts of the California laurel, *Umbellularia californica* Nutt.; California hazel, *Corylus rostrata* Ait. var. *californica* A. DC.; and the seeds of the wild sunflowers, *Helianthus* (many species); desert sun-

Fig. 15.—Indian acorn caches or granaries in the Yosemite Valley, California. These storage facilities, while freely accessible to insect pests, were on the whole quite satisfactory because of their height and thorough ventilation. Acorns submerged in ponds and streams were, however, much better protected. (Photograph by Dr. C. Hart Merriam, © National Geographic Society, 1918.)

flower, *Geræa* spp., and of other *Compositæ*, of buttercups, *Ranunculus* (many species), wild oats, *Avena fatua* Linn., and many wild grasses, cat-tails, *Typha latifolia* Linn. and *T. angustifolia* Linn., honey mesquite, *Prosopis juliflora* DC. var. *glandulosa* Ckll., screw-bean mesquite, *P. pubescens* Benth., yuccas, and of the Indian pond lily, *Nymphæa polysepala* (Engelm.), were among the most important, but the seeds of countless others were also utilized.

Of the wild fruits and berries, the more important ones used were those of manzanita, *Arctostaphylos* (many species), the berries being dried and also used for making a cider-like drink; madrona, madrono or madrone, *Arbutus*

menziesi Pursh; the California wild grape, *Vitis californica* Benth.; the desert grape, *V. girdiana* Munson; the blue elderberry, *Sambucus glauca* Nutt.; black elderberry, *S. velutina* D. & H.; huckleberries and billberries, *Vaccinium* (several species); squaw bush, *Rhus trilobata* Nutt.; lemonade berry, *R. integrifolia* B. & W.; sugar bush, *R. ovata* Wats.; western chokecherry, *Prunus demissa* (Nutt.); bitter cherry, *P. emarginata* (Dougl.); islay or Catalina cherry, *P. ilicifolia* Walp and the var. *integrifolia* Sudw.; Sierra plum, *P. subcordata* Benth.; toyon or California Christmas berry, *Photinia arbutifolia* Lindl.; salal, *Gaultheria shallon* Pursh; California blackberry, *Rubus vitifolius* C. & S.; thimbleberry, *R. parviflorus* Nutt.; salmonberry, *R. spectabilis* Pursh; western raspberry, *R. leucodermis* Dougl.; wild currants, *Ribes* (a number of species); wild gooseberries, *Ribes* (many species); wild strawberries, *Fragaria* (several species and varieties); and cactus fruits. All were in common use wherever found.

Bulbs and roots were extensively gathered and formed an important article of food. The more important bulbs used are *Brodiæa* (many species), *Bloomeria* (several species); wild onions, *Allium* (many species); soap plant, *Chlorogalum parviflorum* Wats., and the most important, at least in some of the mountainous sections, was the camass,[6] *Camassia quamash* (Pursh), and *C. leichtlini* (Baker), which grew in wet meadows or grassy plains of the Sierra and North Coast Range Mountains. Many other liliaceous plants were also utilized. The roots of brown rape, *Orobanche tuberosa* (Gray); squaw-root, *Carum gairdneri* Gray; hog-fennel or wild parsnips, *Lomatium macrocarpum* (Nutt.), *L. piperi* C. & R., and related species, and of many other plants were also eaten. The succulent stems of ferns and the leaves of cruciferous plants and many other plants were eaten raw or cooked. Greens were a great favorite and the members of some tribes ate so freely of fresh bur clover that not a few required severe treatment for bloating.

Tobacco was smoked by nearly all California tribes and was eaten by a few. Two wild native species were used: both had white or greenish flowers and were strong and ill smelling. One known as coyote tobacco, *Nicotiana attenuata* Torr., grew in the dry stream and river beds and the sandy or gravelly river valleys from low levels to 4000 feet altitude. The other known as Indian tobacco, *N. bigelovi* Wats.,[7] was common in the river valleys and foothills. The tobacco frequently grew about the Indian villages or adjacent thereto and was collected without thought of cultivation or selection. The Yurok and Hupa Indians of Northern California planted tobacco on burned over hilltops and tended the plants somewhat, but not sufficiently to be classed as agriculture. This was done not to secure a better or greater supply, but to guard against the possibility of using tobacco which came from seeds of plants growing in graveyards, concerning which they had great fear.[8] The Yokuts, Kitanemuk, and Kawaiisu Indians ate tobacco mixed with lime to relieve fatigue. Tobacco was also offered religiously by the Yurok, Yaki and Yokuts, and a decoction with water also formed a drink of the Yokuts.

[6] This plant should not be confused with the death camas, *Zygadenus venenosus* Wats., which is a close relative and grows in similar places.

[7] Jepson, W. L., *Manual of flowering plants of California*, p. 889 (1925).

[8] Kroeber, A. L., *Handbook of Indians of California*, Bur. Am. Ethnology, Bul. 78, p. 88 (1925).

The tolguacha, *Datura meteleoides* DC., and *D. discolor* Bernh., were utilized in preparing a drink which produced visions and other sensations occasioned by a powerful drug. The use of this drink was extensive and was the most serious intemperate habit of the natives.

The Chemehuevi and the southern Paiutes now and then farmed small patches of ground.[9] The Mohave, who lived along the Colorado river from the Grand Canyon to the Gulf of Lower California, practiced agriculture similar to that of the Egyptians along the flooded Nile. In a region of light rainfalls and knowing nothing about irrigation, they planted the flooded bottom lands after the high flood waters receded in May and June. The seeds were planted in the soft mud. The abundance of moisture, rich soil and intensive sunshine quickly produced an abundant crop with little effort on the part of the natives. Thus they grew many varieties of corn and beans, and also pumpkins. Wheat was early introduced by the Spanish. Watermelons and cantaloupes were also grown, but it is supposed that they were introduced.[10] Melons are mentioned by Vinegas as growing on the Colorado River in 1758.[11]

I have given this rather extensive treatment of plants to show how completely they formed a part of the life of the native Californian and also to show that he must have had as intimate knowledge of the animals. It is true that big game was only rarely taken by certain tribes and was in no sense a part of the regular diet. The remaining one-fifth of their food was made up almost entirely of such small animals as fish, which was the most important item, coyotes, rabbits, hares, squirrels, gophers, skunks, rats, mice, birds, lizards, snakes, frogs, other small animals and a large number of insects.

That insects were equally well known to the Indians is apparent. Sufficient evidence has been collected to prove this beyond a doubt, but the entomological knowledge of the Indians does not appear to have so strong an appeal to the ethnologist as most other subjects and it has therefore been seriously neglected. Insects were used in religious rites, as medicines, foods, and in a number of other ways.

Insects in General

Body and head lice (Fig. 16). All primitive peoples were lousy. In introducing this subject before the members of the Entomological Society of America at Philadelphia on December 28, 1926, the eminent authority, Geo. H. F. Nuttall, remarked that "our forefathers were all lousy; we are only less so." Lousing, or de-

[9] *Ibid.*, p. 597 (1925).
[10] *Ibid.*, pp. 735–736 (1925).
[11] U. S. Dept. Agr., *Yearbook 1925*, p. 420 (1926).

lousing as it is frequently spoken of in America, was practiced by all. The Indians (Hawaiians and many more civilized peoples) however, used a somewhat different method of disposing of the

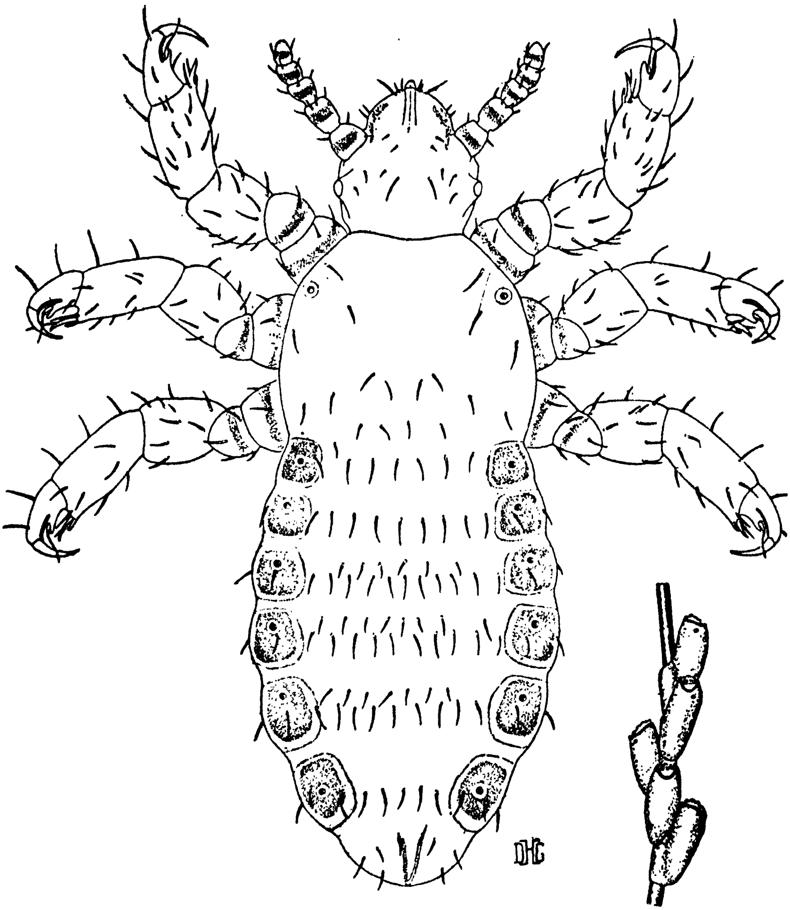

FIG. 16.—The head louse, *Pediculus capitis* DeGeer, was an unwelcome guest among the Indians. The natives sought to rid themselves of the pernicious insects by means of the sweat house, frequent plunges into water, and by plastering their heads with mud. All captured lice were eaten. Adult and eggs. (Eggs after Nuttall, 1917–1918.)

captured lice than did our immediate ancestors. They ate them! Some of the Indians did try to rid their bodies of these unwelcome guests, by means of the sweat house and by frequent plunges into the rivers and lakes. The Mohave Indians plastered clay or mud

on their heads to kill the vermin.[12] It does not appear that any of them resorted to plant decoctions or animal oils for this purpose.

The Cupeño Indians used the word *nauwilot* for body louse and the same word was also used as a clan name.[13] (See body lice under legends, p. 45.)

Fleas, like lice, were very abundant but their presence did not appear to greatly annoy the Indians. They did, however, figure in myths and legends. (See p. 45.)

A **blowfly** song was sung to the dogs of the Shasta Indians "to increase their power of scent and the ability to frighten game."[14] There is no way of knowing the species involved, but inasmuch as the bluebottle and greenbottle flies were introduced during the Spanish occupation, the reference may be to any of a number of native muscid or sarcophagid flies. The purpose of the song is sufficient to show that the Indians were familiar with the habits of these insects. That flies were troublesome is shown in a girls' ceremony held by the Luiseño Indians in which "each girl had her head covered with an openwork basket to keep the flies off." [15]

The **mosquito** was known as *sampulyka* by the Mohave. Because of the great abundance of snow mosquitoes in the higher mountains, the fresh water mosquitoes along the rivers and the sloughs of the great interior valleys, and the pestiferous salt marsh mosquitoes in the San Francisco Bay region, it is surprising that so little early information is to be found regarding these insects. They were probably taken as a matter of course as were flies, lice and many other common insects.

Wax and gum from the exudations of **scale insects** (*Coccidæ*) were used by many of the natives for mending pottery, waterproofing baskets, fastening the sinew backing of bows, and even for chewing. Among the coccids thus used were **the creosote lac scale,** *Tachardiella larræ* (Comstock) (*Tachardia*), which infests the creosote bushes in southeastern California and in Arizona and which produces an abundance of clear reddish lac. It was applied hot and used to mend and waterproof baskets and to fasten the sinews to

[12] Kroeber, A. L., *Handbook of Indians of California*, Bur. Am. Eth., Bul. 78, p. 633 (1925). The Indians were aware of the fact that this treatment had to be repeated, because the eggs or nits were not killed with the mud.

[13] *Ibid.*, p. 690 (1925).

[14] *Ibid.*, p. 294 (1925).

[15] *Ibid.*, p. 674 (1925).

bows.[16] **The oak wax scale,** *Cerococcus quercus* Comstock (Fig. 17), which occurs on oak trees in the semiarid mountain regions of southern California and in Arizona, surrounds the body with thick globular masses of bright yellow wax, which is claimed to have been used as chewing gum by Indians.[17]

FIG. 17.—The females of the oak wax scale, *Cerococcus quercus* Comstock, encase their bodies in a thick layer of yellow wax, which was used by the Indians in their arts and for chewing gum. This insect infests the oak trees of the semiarid regions in southern California and Arizona.

The irregular wax scale, *Ceroplastes irregularis* Cockerell (Fig. 18), infests various species of *Atriplex* in the desert and mountainous portions of southern California, Arizona, and New Mexico. It produces an abundance of cream-colored or whitish wax which was available for many purposes.

Ants were well known by all the Indians and their bites and stings were considered of medicinal value by many tribes. The Luiseño had an ant ceremony for boys in which the lads were placed directly upon ant hills or into pits in which ants were placed and were severely bitten and stung, after which the offending ants were brushed from the naked bodies with nettles.[18] A similar method was recommended for rheumatism of the old folks. (Also see p. 41.)

Mohave women painted their faces in **butterfly** patterns in red and yellow in addition to many other designs used.[19] *Hatimnin,* meaning butterfly, was a girl's name among the Karok. The large silken cocoons of **the ceanothus silk moth,** *Samia euryalus* (Boisduval) (*S. rubra* Behr) (Fig. 19), and of **the polyphemus moth,** *Telea polyphemus* (Cramer), were used as rattles in ritualistic

[16] Essig, E. O., *Insects of Western N. Am.*, p. 287 (1926).
[17] *Ibid.*, pp. 301–302 (1926).
[18] Kroeber, A. L., *op. cit.*, p. 672 (1925).
[19] *Ibid.*, p. 732 (1925).

ceremonies and as musical instruments. The empty cocoons were partially filled with small pebbles and tied together at the end of a stick for a rattle. From two to thirty or forty were thus tied, with wild hemp, together, alone or with feathers. They were in general use among the Pomo, Yuki, Maidu, and Yokuts, who inhabited northern and central California. That the turtle shell and gourd rattles replaced these among the Indians in the southern part of

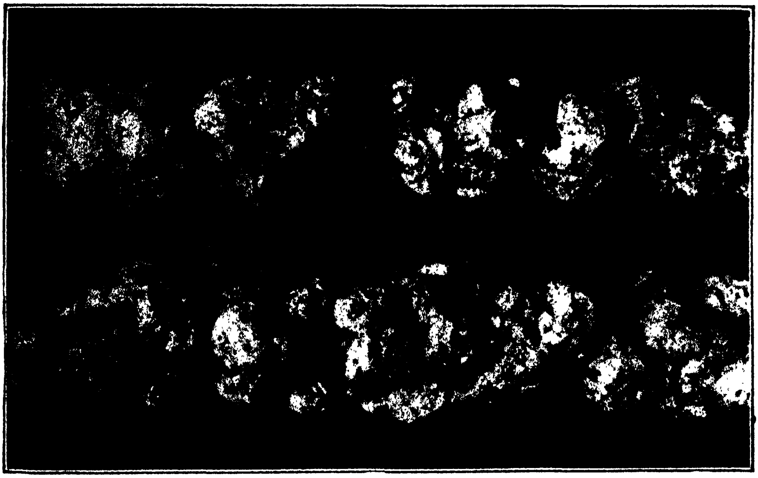

FIG. 18.—The wax produced by the females of the irregular wax scale, *Ceroplastes irregularis* Ckll., was used by the California Indians for mending pottery, waterproofing baskets, fastening the sinew backing of bows, and other purposes. This coccid is common on atriplex in the arid regions of southern California, Arizona, and New Mexico.

the state may be due, not only to the fact that some of them were more agriculturally inclined, but also to the scarcity of cocoons in that region.

The tenebrionid ground beetles (see legend, p. 46), were known because of their offensive smell and called *humahnana* by the Mohàve who also knew the dragonfly nymph as *asakwa'ilya* and a caterpillar as *nyikha*. The Yuma Indians called the red ant, probably the desert agricultural ant, *Pogonomyrmex desertorum* Wheeler, *sikupas* and to them an insect was *estamadhun*, while a grasshopper was *kwisku* and a beetle was *nyo'ilcha*.[20]

[20] *Ibid.*, pp. 742–743 (1925).

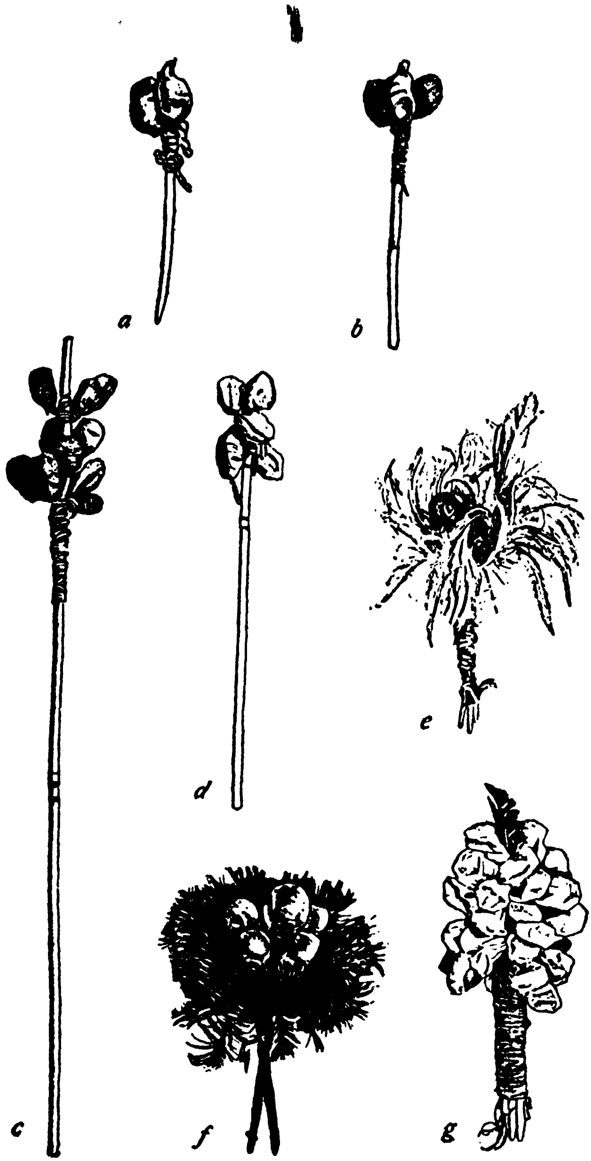

Fig. 19.—The large cocoons of the ceanothus silk moth, *Samia euryalus* (Bdv.), and the polyphemus moth, *Telea polyphemus* (Cramer), were used by the central California Indians as rattles in spiritualistic ceremonies and as musical instruments. After the chrysalids were removed and eaten, the cocoons were partially filled with small pebbles and securely tied together at the end of a short or long stick. From two to thirty were required for a rattle, which was either plain or ornamented with feathers. *a*, Yokuts; *b*, Maidu; *c*, *e*, *g*, Pomo; *d*, Yuki; *f*, Miwok. (After A. L. Kroeber, 1925.)

Ladybird beetle and the Juaneño.[21] "A custom was observed in all their new settlements to appoint as chief or captain the eldest of the families, and to him was given the name of *Nu*, and to the second in power, that of '*Eyacque*' (*Eyake* or Coyote). Their wives were named also: the first, '*Coronne*' (*Korone*), and the second '*Tepi*.' These same appellations were given to a small insect, or fly, which was abundant in the fields and gardens, called by us the *lady bug*. The red ones were *Coronnes*, and the yellow, *Tepis*. The first was given to the wife of the chief, in commemoration of the *Capitana* of *Putuidem*, and that of *Tepi* to the wife of *Eyacque*, for the reason that the two names implied equality, as demonstrated in the character of the insects, which varied only in their colors." [22]

INSECTS AS FOOD

It is not at all strange that the California and other western Indians made use of a large number of insects for food. The abundance of certain insects at regular seasons, the ease of gathering and surety of preservation were some of the reasons for this. Insects form a staple food of many primitive peoples and it is just as natural to include them in the diet as any other type of animal life.

Grasshoppers were held in the greatest and most universal favor. They were always abundant in many parts of the state every year.[23] They constituted a clean, nutritious, and healthy food. The common method of preparation was to roast them in the hot coals and ashes and then grind them into a meal which could be made into a gruel or mixed with acorn meal into a combination mush-gruel, or baked into a bread. J. M. Hutchings [24] relates that grasshoppers were considered a great food luxury of the Indians. They were caught and prepared in various ways. They were threaded on a string and slightly roasted, then eaten, or the grass was fired killing and roasting the grasshoppers, which were gathered and eaten or stored for future use. "The most effectual method for securing grasshoppers, when they were abundant, is to dig a hole suffi-

[21] Rev. Fr. Friar Geronimo Boscana, *Chinigchinich. Hist. Acct. of the Acagchemem Nation at San Juan Capistrano*, in Alfred Robinson's *Life in California* (N. Y., 1846), p. 331.

[22] The newly pupated ladybird beetles are yellow and after a few days' exposure to the air and light, become red.

[23] See list of grasshopper invasions, p. 92.

[24] *In the heart of the Sierras, the Yosemite Valley*, etc. (Oakland, Calif., 1888), pp. 428–430, 1 fig.

ciently deep to prevent their jumping out; then to form a circle of Indians, both old and young, with a bush in each hand, and commence driving them towards it until they fall in and are caught (Fig. 20). They are thence gathered into a sack and saturated with salt water;[25] after which a trench is dug in which a good fire is built, and when it is sufficiently heated, the ashes are cleaned out, a little grass put upon the bottom, when the grasshoppers are put in, and covered with hot rocks and earth until they are sufficiently cooked. They are then eaten in the same manner as we eat shrimps; or are put away to mix with acorn or seed mush, when they are ground into a kind of paste."

According to Taylor[26] "The Indians take the grasshoppers in great numbers by sweeping them into holes or piles, or by surrounding them with fire and driving them into the center, and afterwards roasting and pounding them for food. But this is always found to sicken the Indians—a fact which has been noted by the pioneer settlers and natives of old, as also by many travellers and voyagers who have visited California and the Rocky Mountain country, and also by the Jesuits of Lower California."

There seems to be no foundation for the supposition that grasshoppers sickened the Indians as related above, because not only the American Indians, but many other primitive races regularly consumed quantities of these insects.

A relative of my family, who lived near where the present town of Wheatland now stands during the early fifties, related that she often observed the Indians capturing and eating these insects on "the plains" of the Sacramento Valley when she was a girl. The method then used in that place was to build a large fire which was reduced to a bed of coals. The Indians then formed a large circle and drove the grasshoppers into the coals where they were soon roasted, removed and eaten at once or preserved for the future. In other places pits were dug in which the fire was built and into which the grasshoppers were driven or deposited. At times the insects were captured and killed and dried in the sun, after which they were ground into a meal. The species most often taken in abundance in the high mountain meadows throughout the state is **the yellow-winged or pellucid grasshopper,** *Camnula pellucida* (Scud-

[25] It seems most unlikely that salt water was used, except near saline lakes.

[26] *An account of the grasshoppers and locusts of America*, condensed from an article written and furnished by Alexander S. Taylor, Esq., of Monterey, California, Smiths. Inst., Ann. Rept., 1858, pp. 205–206 (1859).

FIG. 20.—Indians catching grasshoppers for food. They are driving a portion of a swarm into a hole from which still issues the smoke of a fire previously built to kill and roast the insects. (After J. M. Hutchings, 1888.)

der). Associated with it in the northern part of California **and also** occurring in the Sacramento Valley, in large numbers, were **the lesser migratory locust,** *Melanoplus atlanis* (Riley); **the red-legged locust,** *M. femur-rubrum* (DeGeer); **the two-striped locust,** *M. bivittatus* (Say); and **the valley grasshopper,** *Œdaleonotus enigma* (Scudder). The dominating species in the western Sierra foothills and the Sacramento Valley was **the devastating grasshopper,** *Mela-*

FIG. 21.—The fat larvæ of wood boring insects were a source of food for the Indians during the winter months when other food was scarce. By removing the bark of dead trees and tearing apart rotting logs, these grubs could be secured without much effort. This is a photograph of the larva of the California prionus, *Prionus californicus* Mots., and is only one of many common wood borers. In these days they make excellent trout bait in the mountain streams and lakes.

noplus devastator Scudder, while in the lower San Joaquin Valley **the differential grasshopper,** *M. differentialis* (Thomas), was to be found in abundance on the succulent vegetation along the rivers and in marsh areas. **The large green valley grasshopper,** *Schistocerca venusta* Scudder, often overran the mesquite and other desert vegetation in southern California and occurred abundantly on the cattails growing in wet places throughout the great interior valleys and foothills. All of these species and perhaps many others were con-

FIG. 22.—During the winter months the leatherjackets, or larvæ of crane flies, Tipulidæ, often appear in enormous numbers, particularly in grasslands. While they are somewhat tough and watery, they were no doubt meritorious in the eyes of hungry Indians. They are also to be found in rotting logs, under wet leaves, and along the margins of streams, pools, and lakes.

sumed. Powers[27] states that the Nishinam of Placer County use *hallih* or crickets for food after roasting. This more likely refers to grasshoppers since crickets are scarce there and grasshoppers are

[27] Powers, Stephen, *Contrib. to N. Am. ethnology*, U. S. Geog. & Geol. Surv. of Rocky Mt. Region, Dept. Int., p. 430 (1877).

very abundant. **The black field cricket,** *Gryllus assimilis* (Fabr.), however, is often very abundant along the Sacramento and San Joaquin Rivers.

Grubs or larvæ of beetles, particularly those of the long-horned or wood boring Cerambycidæ, were considered a great relish. These vary from 7 mm. to 60 mm. in length and consist largely of fat. They were removed from dead or dying trees and eaten raw. The

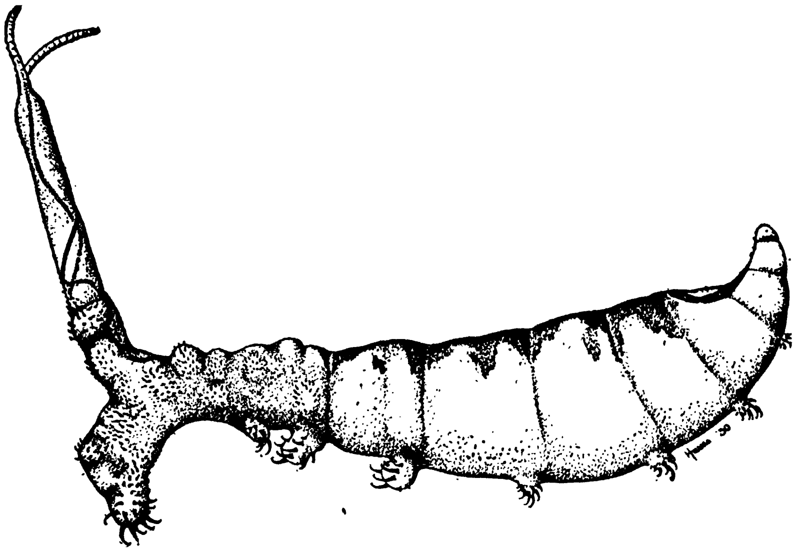

FIG. 23.—The pupa of the koo-tsabe fly, *Ephydra hians* Say. Note the long spiracular tube at the posterior end and the hooks for clinging to the rocks and bottom. The larvæ and pupæ often occur in enormous numbers in the alkaline lakes east of the Sierras.

huge grub of **the pine sawyer,** *Ergates spiculatus* Leconte, and **the California prionus,** *Prionus californicus* Mots. (Fig. 21), were real finds and were much worth while. They could be obtained by tearing to pieces old logs and stumps of pine, fir and other coniferous trees and the latter also from oaks, alder, cottonwood, aspen, walnut, and other trees. The grubs of **the ribbed pine borer,** *Rhagium lineatum* Olivier, could be taken in quantities during the winter and spring from beneath the bark of dead pine trees in the foothills and lowlands. **The nautical borer,** *Xylotrechus nauticus* (Mann.), and other species of the same genus, occur under the bark of dead oaks, walnut, madrona, willows, etc., and those of *Neoclytus conjunctus* (Lec.), and allied species, occur abundantly under the bark of dead

poplars, willows, madrona, oaks, ash, etc. They reach full size in the spring and are easily procured in the wooded areas. Many

Fig. 24.—The puparia of the koo-tsabe fly, *Ephydra hians* Say, washed up in a large windrow on the shore of Mono Lake, California. Here they were readily gathered in quantities by the Indians. (Photograph by E. A. Schwarz in 1909, after J. M. Aldrich.)

other species such as the spotted pine sawyer, *Monochamus maculosus* Hald., and the black pine sawyer, *M. scutellatus* Lec., which are found in fire-scorched, injured, and dead coniferous trees,

and countless others infesting every kind of tree and shrub in desert, arid and regions of abundant rainfall, were eaten. Then too there were the smaller, but more abundant larvæ of the barkbeetles, which were available in great quantities in all of the coniferous forests. White grubs were more difficult to find in the soil and the exposed larvæ of the leaf beetles (Chrysomelidæ) and the ladybird beetles (Coccinellidæ) are generally unpalatable because of offen-

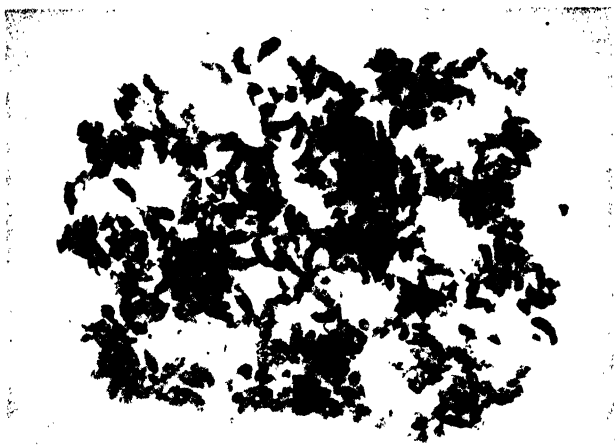

FIG. 25.—Koo-tsabe, the rubbed puparia of the ephydrid fly, *Ephydra hians* Say, as gathered by an Indian woman at Mono Lake in 1925 and on exhibit at the Yosemite National Park Museum.

sive body secretions. Weevil grubs occurred in acorns and other nuts which no doubt added to the oily and nutty flavor. White grubs, the larvæ of the scarabæid or June beetles, were also eaten. The Indians at Northfork on Fine Gold Gulch, a tributary of the San Joaquin River in Madera County, are reported to have regularly eaten the adults of **the white-striped June beetle,** *Polyphylla crinita* Leconte. Undoubtedly other members of this large family were also employed as food.

Maggots, or the larvæ of flies, also formed an important food in some sections, but these were not the maggots which we usually think of as breeding in dung, carrion, and decayed vegetation.

Leatherjackets or the larvæ of crane flies (Tipulidæ) (Fig. 22), particularly those of **the giant crane fly,** *Holorusia rubiginosa* Loew, which occur along the banks and at the bottoms of fresh water streams, and the smaller meadow and grass infesting species,

Tipula simplex Doane, *T. derbyi* Doane and *T. quaylii* Doane, are abundant in the late winter and early spring when other food is scarce and formed a ready and available, though watery, supply of food.

The most interesting maggot food used by the Indians is to be found among the Mono and Koso (Shoshone) and Paiute tribes and is known as **koo-tsabe** or **koo-chah-bee** by the Paiutes.[28] This food is prepared from the puparia (Figs. 23–25) of a fly, *Ephydra hians* Say (Fig. 26), the larvæ of which live in the brackish waters of Mono Lake, Owens Lake, East Lake, and Borax Pond near Clear Lake in California and also in other Western states. The queer looking larvæ of this fly live on the bottoms of the lakes and pupate on the bottoms and around the shores. J. M. Aldrich, world authority on Diptera, has given a most interesting account of this insect, portions of which I quote.[29]

Mono Lake is subject to violent winds in the latter part of summer, and the disturbance of the lake loosens many of the puparia, so that they float to the surface and wash ashore. The late Wm. H. Brewer,[30] of Yale, made some observations here in July, 1863; I quote a portion of his letter to S. W. Williston (published by Williston, Trans. Conn. Acad., July, 1883):

> They drift up in heaps along the shore, and *hundreds* of *bushels* could be collected! (Fig. 24). They only grow at certain seasons of the year, and then Indians come from far and near to gather them for food. The worms are dried in the sun, the shell rubbed off by hand, when a yellowish kernel remains (Fig. 25), like a small yellowish grain of rice. This is oily, very nutritious, and not unpleasant to the taste, and, under the name of koo-chah-bee (so pronounced), forms a very important article of food. . . . My guide, an old hunter there, told me that everything fattens in the season of *koo-chah-bee;* that ducks get very fat, but their flesh tastes unpleasantly from it, and the Indians get fat and sleek.

[28] Also spelled "cozaby" and the Indians eating these were spoken of as "Cozaby Piutes." Chalfant, W. A., *The Story of Inyo*, pp. 15, 19 (1922).

J. M. Hutchings refers to this insect food as "Kit-chavi" in his book, *In the Heart of the Sierras, the Yosemite Valley, etc.*, pp. 427–428 (1888).

[29] *Jour. N. Y. Entom. Soc.*, vol. 20, pp. 90–92 (1912).

[30] William Henry Brewer (1828–1910), was a noted chemist, botanist, geologist, and agriculturist, who came to California in 1860 as a member of the State Geology Survey of California under J. D. Whitney. This position enabled him to travel over the entire state and gave him a splendid opportunity for studying nature and for collecting specimens. He was professor of chemistry at the University of California in 1863–64 after which he was called to the chair of agriculture at Yale University, where he remained until his death. Brewer collected insects during his four years' stay in California. One of his finds, the elaterid beetle, *Ludius breweri* (*Corymbites*), was named for him by G. H. Horn in 1871.

My stay at Mono Lake was July 21-24, 1911, and I was informed that the collection of the fly for food would not begin until about September 1. None was left over from the previous year, so I was disappointed in seeing either the material after preparation or the process of putting it up. However, I

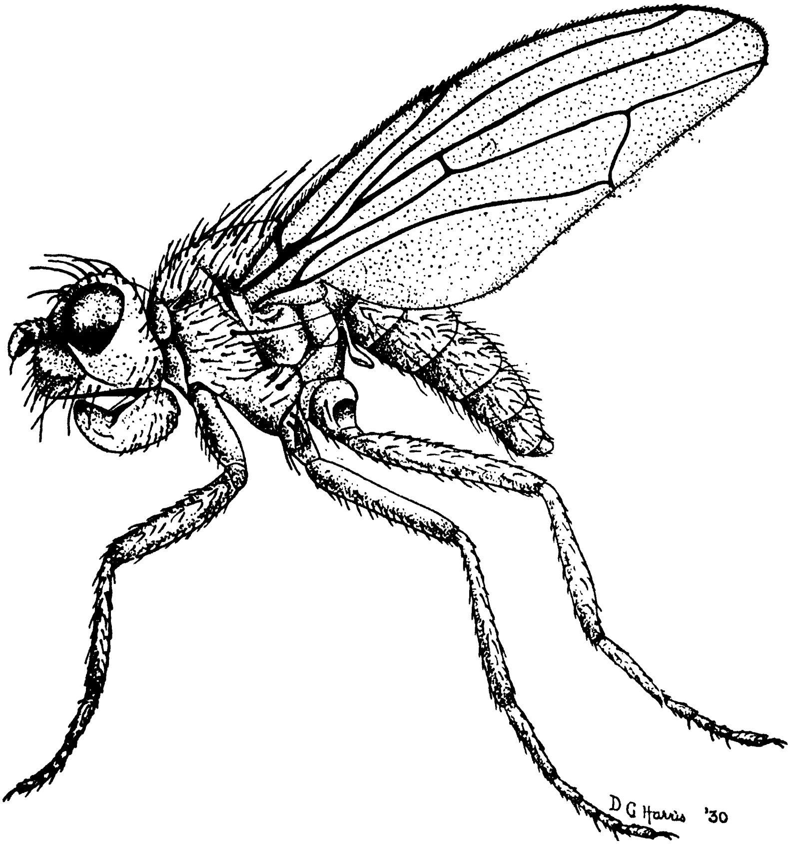

FIG. 26.—The adult koo-tsabe fly, *Ephydra hians* Say.

talked with both Indians and whites about it. There are only a few Indians who collect the material now, although it is known among all the older Indians of the tribe. The name of the food is better spelled "koo-tsabe," accented on the first syllable, the last two letters forming an obscure syllable in which it is hard to distinguish whether the consonant is b or v.[31] "Fat Joe" pronounced it for me many times and I listened very attentively; when I told him it had not been so recorded by earlier investigators, he chuckled and replied in his free and easy English, "Well, you understand I'm giving you the real thing." White people at the lake emphasized the amount of time required to free the little dried pupæ from bits of puparium, dirt, etc.; they thought it hardly worth while for anyone to work at it whose time had any value.

[31] Also spelled *Koo-chah-bie* and *Ka-cha-vee* by some.

Most of the Pah-Ute Indians are now on reservations, one south of Pyramid Lake and one at the north end of Walker Lake, and only a few live near Mono Lake, where they eke out an existence on *koo-tsabe*, dried caterpillars (which I have reported on elsewhere) and pine nuts, adding a minimum of white man's "groceries."

The main centers of this species might be said to be Mono Lake, Owens Lake, and Great Salt Lake—in all three they are exceedingly numerous.

I cannot forbear to include a brief extract from Mark Twain's "Roughing It," about the characteristic fly of Mono Lake, as it is true to life: "You can hold them under water as long as you please; they do not mind it—they are only proud of it. When you let them go, they pop up to the surface as dry as a patent-office report, and walk off as unconcernedly as if they had been educated especially with a view to affording instructive entertainment to man in that particular way."

Another interesting dipterous food of the Modoc and Wintun or Pit River Indians is also described by Aldrich.[32] This consists of an adult leptid fly of the genus *Atherix* which is gathered on the Pit River in great quantities in early summer. The only information available was from the recollections of an early white settler and a Pit River Indian. According to the former the fly occurred in enormous numbers on the Pit River about ten miles below Canby in early summer. Then the Indians fastened a log boom across the river and went above to beat and shake the flies from the bushes into the water which carried them down to the boom where they lodged in great masses. They were dipped up in baskets, prepared for this purpose, and in this state were known as *ha-lib-wah.* After the flies were roasted with hot rocks in a pit in the ground they were reduced to the consistency of head-cheese which was of a reddish-brown color and when cold could be sliced. It was then called *koo-chah-bee* (also spelled *koo-chah-bie*). The Indian remembered as a small boy collecting the flies at the head of a canyon containing a small stream about eight or ten miles northeast of Lookout, Modoc County, where the flies could be scooped up by the tons from the bushes, trees and rocks. They were crushed, made into loaves, baked in ovens of hot stones and called *why-hauts*, and much used for food during the winter.[33]

[32] Aldrich, J. M., *Entom. News*, vol. 23, pp. 159–163 (1912).

[33] In order to locate, if possible, this interesting fly I made a trip to the Pit River region in the month of May on three successive years, 1927–1929, but could find nothing corresponding to the fly described by Dr. Aldrich. At McArthur, the owner of the hotel, who was not only a fisherman himself, but had entertained at his hostelry anglers for many years, could give me no information other than that the fly used for food by the Indians must be the California salmon fly (Figs. 27–28) which abounds in great numbers in that region. This interesting insect, *Pteronarcys*

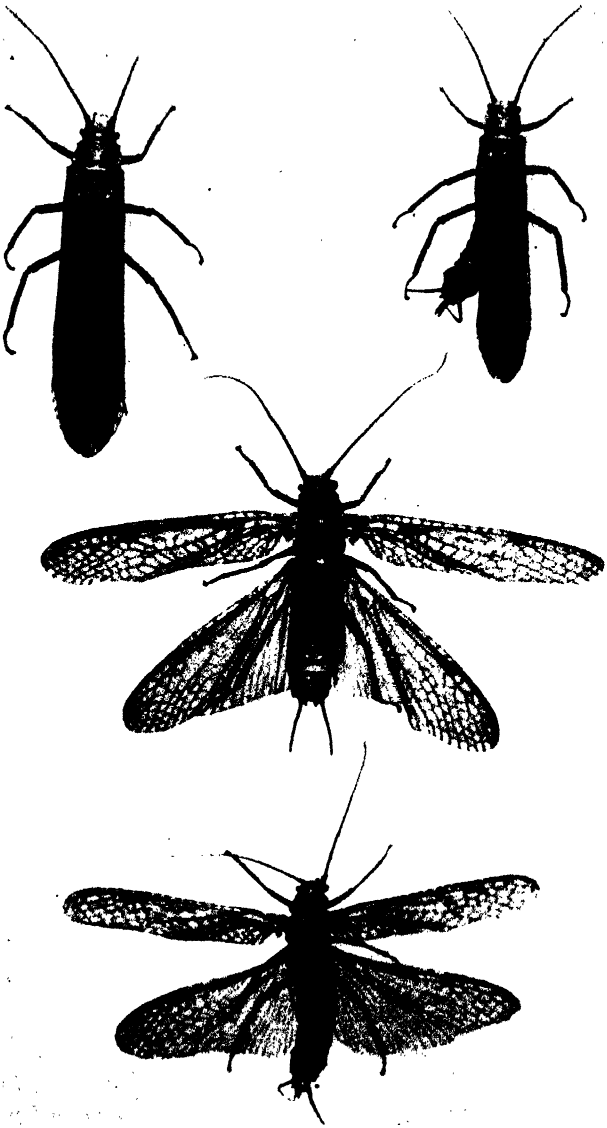

FIG. 27.—The California salmon fly, *Pteronarcys californica* Newport, may have been the insect collected in such great quantities along the Pit River in early days and used for food by the Modoc, Wintun, and Pit River Indians. During the month of May this large stonefly emerges from the streams and rivers of Shasta, Modoc, and Lassen counties in enormous numbers and fairly swarms on the bushes along the waters' edge. They are now commonly used as bait for trout fishing. The specimens photographed were taken on Burney Creek, near the falls, May 19, 1929.

FIG. 28.—The large nymphs of the California salmon fly, *Pteronarcys californica* Newport, emerge from the streams, ascend the near-by vegetation, and emerge as adults. The remaining cast skins are commonly found along the streams of the Sierra Nevada Mountains, and are particularly abundant in the Pit River region.

Many caterpillars were utilized, but those of the pandora moth, *Coloradia pandora* Blake (Figs. 30–35), were the most extensively

californica Newport, appears in the early spring, being usually most abundant in May, and fairly swarms on the bushes along the streams. The adults could be shaken from the bushes and collected in bulk as they readily float on the water. On May 19, 1929, F. H. Wymore and I found adults abundant on the Pit River and Burney Creek. The insect is extensively used for trout fishing in that region.

Extensive power developments in which huge dams have slowed up the Pit River in the neighborhood of Lockout may have changed conditions so that the

used for food.[34] The adult moth (Fig. 30) is a large striking brownish-gray species with black lines and a single black spot and white

FIG. 29.—Pomo Indian woman parching caterpillars before an open fire. Many kinds of hairy and smooth caterpillars were roasted and used for food. (After A. L. Kroeber, 1925.)

scales scattered over each of the fore wings. The hind wings are pinkish with black margins, a black band near the middle and a single oval black spot in each. The pale green eggs are laid in

so-called *Atherix* fly may no longer exist in sufficient numbers to attract attention. Then, too, continued search may yet be directed during a season when the insect may reoccur as of old. The fact that it has not been found is no reason for concluding that it never existed!

[34] Aldrich, J. M., *Larvæ of a saturniid moth used as food by California Indians*, Jour. N. Y. Entom. Soc., vol. 22, pp. 28–31, pl. 1 (1912). Coloradia pandora *Blake, a moth of which the caterpillar is used as food by Mono Lake Indians*, Am. Entom. Soc., Ann., vol. 14, pp. 36–38 (1921).

Keifer, H. H., Coloradia pandora *Blake in Oregon*, Pan-Pac. Entom., vol. 1, p. 143 (1925).

Essig, E. O., *Insects of Western N. Am.*, pp. 670–671 (1926).

clusters on the bark of pine trees in May, June, and July. The young caterpillars appear in August and feed on the needles of yellow pine and Jeffrey pine and often defoliate large areas of

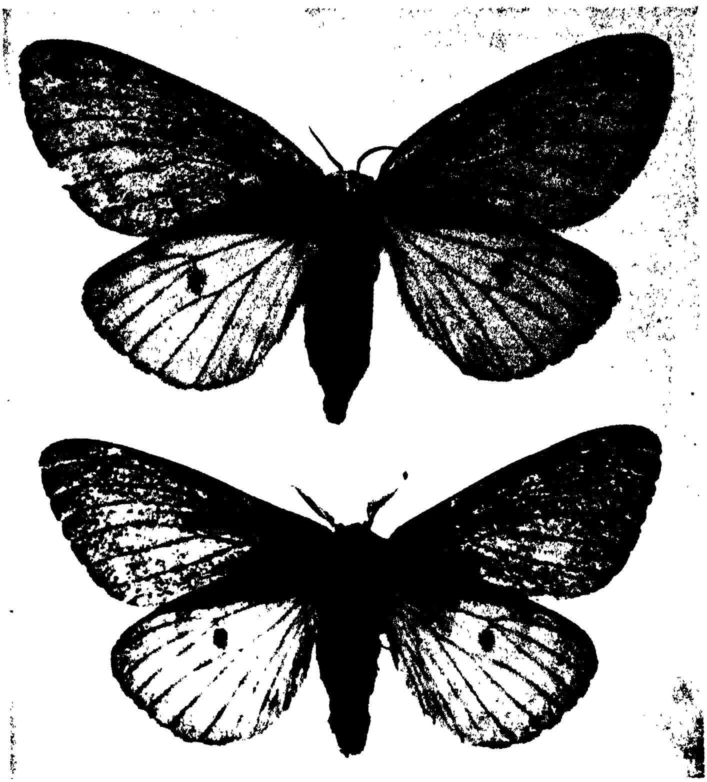

FIG. 30.—The pandora moth, *Coloradia pandora* Blake. Female at top, male at bottom. The general color is gray and the pink hind wings are most conspicuous when spread to view.

standing timber. They remain partially grown during the first winter and do not become full-grown until the following June and July or a full year from hatching from the egg. At maturity they are green or brownish with whitish dorsal cross bands and three broken longitudinal lines, of which the middle is the most conspicuous. They are quite tough, with seven or eight tuberculate spines on each segment, and measure from 40 to 60 mm. in length. When full fed they crawl or drop to the ground where pupation occurs and where they remain during the fall and winter (Fig. 31). The adult moths emerge the following spring. Two years are

required to complete a life cycle, which fact was known to the Indians. This moth occurs throughout the yellow and Jeffrey pine belts of the West and was particularly abundant on the eastern slopes of the Sierras from Mono Lake northward and also in the Klamath Region of southeastern Oregon. The Indians collected the full-grown caterpillars in two ways. One was to dig a trench with straight sides around the periphery of the trees as a barrier to catch the worms that fell from the foliage. They were subsequently gathered and prepared for food. There was a considerable loss due to caterpillars going into pupation in the ground inside the trenches and by falling without the confines of the barrier.

What appears to be the most approved method was to clean up under the trees so as to eliminate fire hazard and prepare a smooth floor, often also encircled by a trench (Figs. 32–33). A fire smudge was then made, the smoke of which caused the caterpillars to drop in countless numbers. They were gathered and killed by mixing them with heated earth, coals, and ashes, and allowing them to remain as long as an hour or until they were partly cooked and dried (Fig. 34). The dirt was removed with a cone-shaped sifter and the caterpillars dried for two days in the bark huts of the natives (Fig. 35). One chief dried as much as one and one-half tons during the summer of 1920. The caterpillars were boiled into a stew which was known as *pe-ag-gie* by the Mono Indians. The Klamath and Modoc Indians also roasted the pupæ for food.[35] When dried this was a non-perishable food which was stored for winter use. In this condition it was called *papaia*. The reservation Indians are still using this food.

The Californians also made use of the sweet crystalline exudations of aphis and coccids which we call honeydew and which the early whites designated as Indian honey. It was particularly abundant on the willows growing along the streams and on and under many of the shrubs in the arid regions where it collected over a period of years. The galls of the cynipid wasp, *Disholcaspis eldoradensis* (Beutm.), which often occurs abundantly on the stems of *Quercus lobata* Nee, *Q. dumosa* Nutt., *Q. durata* Jepson, and *Q. garryana* Dougl., secrete quantities of honeydew, which is commonly gathered by honeybees, but it is not known if the Indians made use of it.

[35] Patterson, J. E., U. S. Dept. Agr., Bur. Entom., *Insect Pest Survey*, vol. 3, p. 94 (1923). The pupæ were called "bull quanch" by the Klamath Indians. Keen, F. P., Calif. State Dept. National Resources, Forestry Div., *Bul. 7*, p. 78 (1928).

FIG. 31.—The caterpillars and chrysalids of the pandora moth, *Coloradia pandora* Blake, were used for food by the Klamath, Modoc, Mono, Paiute, and other Indians inhabiting the yellow pine belt indigenous to this insect. (Specimens furnished by F. P. Keen, 1929.)

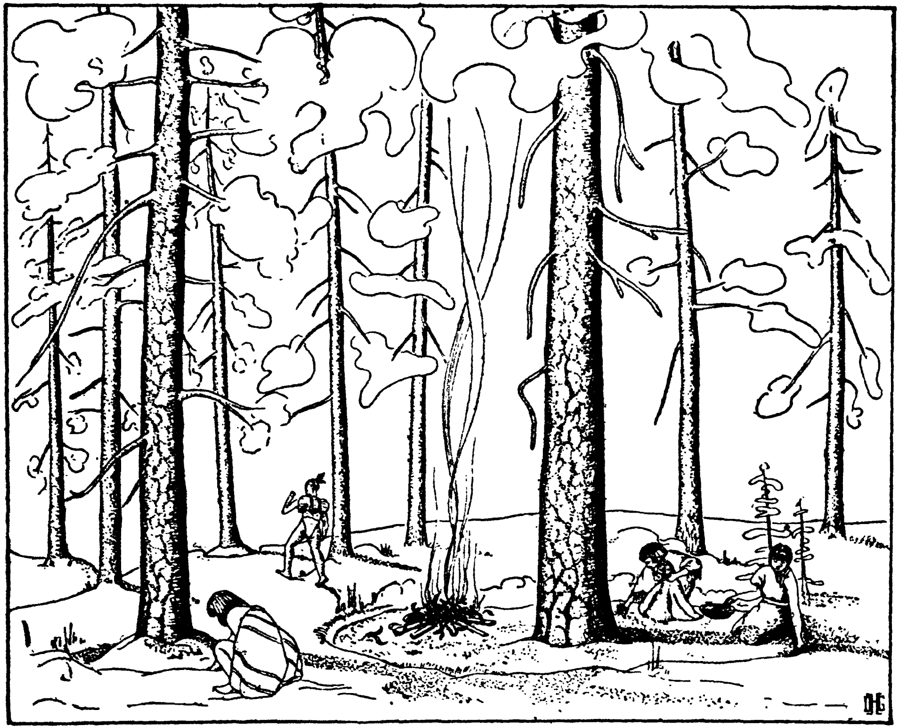

Fig. 32.—A sketch showing the methods employed by the Indians in catching the caterpillars of the pandora moth, *Coloradia pandora* Blake. At the left is an earthen cone at the base of the tree surrounded by a trench in which the larvæ were trapped. At the right the ground has been cleared of rubbish and the area surrounded by a trench. The smoke from the fire causes the caterpillars to drop from the pine trees and they are gathered by the women.

The larvæ of wild bees and of yellow jackets, hornets and other wasps were readily eaten raw by the Indians of northwestern California. They first smoked the nests to subdue the adults. Besides using ants in various ceremonies, some species, particularly the large red stinging ant, *Formica fusca* Linn., and probably other species, were boiled and administered internally as a cure for diseases of the alimentary canal by the Yokuts.[36] Ants were thought to produce as well as to cure diseases.

Some Indian Legends and Myths Featuring Insect Characters

Isoptera—Termites or white ants. The following Mohave legend or portion of a shaman's[37] story has to do with termites or the so-called white ants.

"*Achyeka-ant* was the oldest of the four. He, too, made four roads of spittle and breath. Then he called himself 'night body' *Kutinyam-himata*, and sank down to the heart of the earth, *amata-hiwa*. There he was no longer a person, but a yellow ant; and there he made four more roads in the darkness. He emerged, and now called himself 'bright body,' *Himata-anyayi*, who would live in the roots of a tree, the heart of a tree, and make his house there. His body is here on earth, his shadow below. It is his night body, the underground shadow, that bites men. It goes through the veins, of which one leads to the heart. He eats the heart and the man begins to die. He is a long time dying; but at last *Achyeka* takes the man's shadow with him to his house. But he failed to make stone and earth alive as he tried. So I take a very fine earth, rub it between my hands, and put it on the sick person's body. So I stop the roads to the middle place of *Achyeka*, and bring the person's shadow back to him, and he becomes well."[38]

The Jerusalem or sand cricket (*Stenopelmatus*). This interesting insect (Fig. 36) was looked upon with almost human regard by the Indians of northwestern California. The large shining heads were sufficiently human-like to excite awe and wonder. They are sup-

[36] Powers, Stephen, *op. cit.*, p. 378 (1877).

[37] A shaman was one supposed to have "individual control of the supernatural through a personally acquired power of communicating with the spirit world." Shamans were either male or female and were the "medicine men" of the tribes.

[38] Kroeber, A. L., *Handbook of Indians of California*, p. 777. The yellow ant, *Achyeka*, is figured in the beginning of this story as having come from eggs which were formed from the glue in the joints of the dead Sky-Rattlesnake.

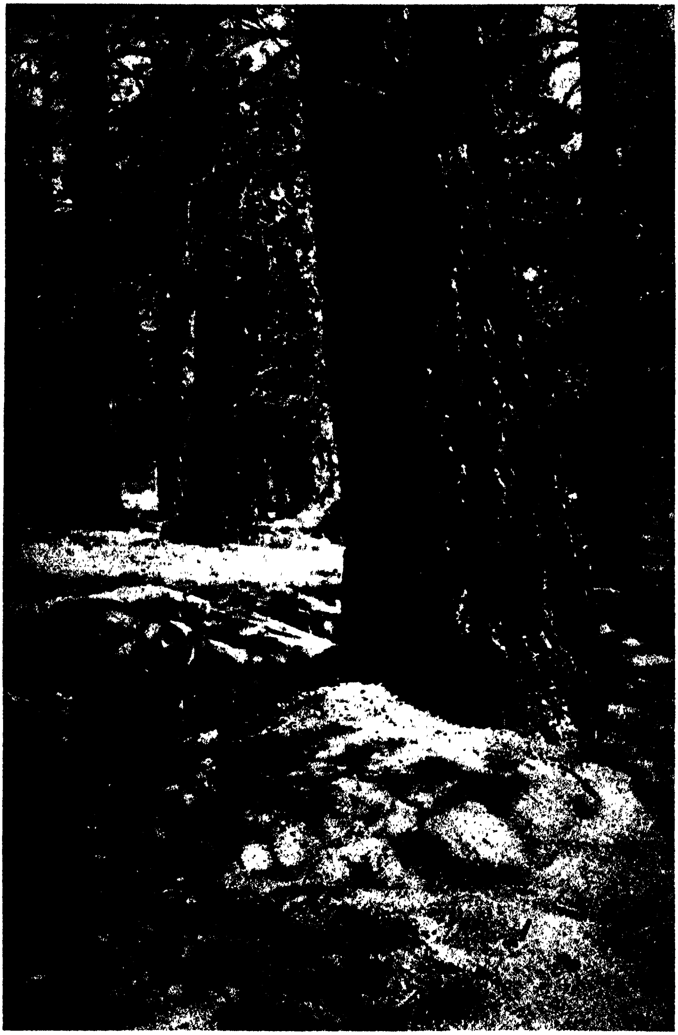

FIG. 33.—A trench and inner cone encircling the base of a yellow pine tree, constructed by the Indians to capture the falling caterpillars of the pandora moth. (Photograph taken in the Inyo National Forest by J. M. Miller, 1926.)

posed to have brought mortality and death to mankind, when he might have been immortal.

Among the Yuroks " *Wertspit*, the locust larva (*Stenopelmatus*), wished death into the world." [39] Among the Wiyots also *Spina-*

[39] *Ibid.*, p. 74.

garalu, another name for the same insect, is responsible for the origin of death.[40]

Frog and sand cricket—Wiyot Myth.[41] "Frog was married, she had a child. It died. She did not feel well; she was sorry. She was going to go to visit. At destination she arrived. She said she felt badly, 'Now what do you think? As for me, I would like to come back.' Sand Cricket, 'As for me, that way I do not think. It will be no good to happen that way.' She went back. Sand Cricket her children many there were. One died; she too, the same it was. She was sorry. She thought, 'Neighbor I am going there to see.' She went to speak to her. At destination she arrived. 'What do you think? As for me, I should like to see it come back.' Frog said, 'No, as for me, some time ago when I had bad luck not good it happened. I do not want it to happen that way. It is not good to happen that way.' Sand Cricket in hot ashes put her head." [42]

FIG. 34.—The dried caterpillars of the pandora moth, *Coloradia pandora* Blake, as prepared for food by the Indians. When boiled the resulting stew was called *pe-ag-gie* by the Mono Indians. The roasted chrysalids were designated as *bull quanch* by the Klamath Indians. (Photograph furnished by J. M. Miller.)

Cricket or katydid. A portion of a Mohave story runs thus: "The heroes of Chuhuecha are the two brothers called *Hayunye*, an insect, perhaps the cricket, that is said to sing *Chuhuecha* now as it chirps," (followed by a considerable tale of adventures).[43]

Fly and cicada. In a mythological dream tale or shaman's tale the Mohave give the following brief, clear picture of the fly and cicada.

"Coyote, always suspected, was sent away for fire, and then Fly, a woman, rubbed it on her thigh. Coyote raced back, leaped

[40] *Ibid.*, p. 120.

[41] Reichard, Gladys A., *Wiyot Grammar Texts*, Univ. Calif. Pub., Am. Arch. Eth., vol. 22, pp. 183–185 (1925).

[42] And thus burned all the hair from her head.

[43] Kroeber, A. L., *op. cit.*, pp. 763–764 (1925).

over Badger, the short man in the ring of people, snatched the god's heart from the pyre, and escaped with it. *Mastamho* directed

FIG. 35.—A temporary camp of the Washoe Indians in the Calaveras Mammoth Tree Grove in the high Sierras, showing the type of bark huts in which the caterpillars of the pandora moth were dried after being killed and partially roasted in hot coals and earth. (After E. Vischer, 1862.)

FIG. 36.—The Jerusalem or sand cricket, *Stenopelmatus longispina* Brunner, was looked upon with almost human regard by the Indians of northwestern California. The large shining heads were sufficiently human-like to excite awe and wonder.

the mourning, and *Han'ava*, the cicada, first taught how to wail." [44]

[44] *Ibid.*, p. 770 (1925).

Body lice. In a legend of the Chemehuevi [45] the hero, coyote, after the earth emerged from the primeval flood, "failing to find men, marries a louse from whose eggs spring many tribes."

In a Mohave autobiographical anecdote [46] telling how to kill a shaman, one Indian tells how he and his companion attacked the sleeping man and continues, "my companion became frightened, ran off, returned, struck at the shaman's head, but hit only his legs,

FIG. 37.—Where fleas were rampant! These insects were enormously abundant and notoriously annoying in every Indian Rancheria in California following the occupation of the state by the Spanish. The only objects lacking in this picture are the innumerable dogs, introduced later, which fed, incubated, and distributed the pests. When the habitations became unbearable they were burned to the ground, but the new ones were immediately restocked by the inhabitants thereof. This view of an Indian Rancheria, at the place where Yuba City now stands, is from an old print.

and ran off, hardly able to drag his own. *Two women* had been sitting near, *lousing each other*, and at first had not seen what we did. Then they began to cry and wail."

The Pleiades and the flea—Yokut Myth.[47] (Fig. 37). "The Pleiades were five girls and a flea, *baakel.* The girls sang and played all night in the sky. The flea constantly went with them. They did not like other men that came to them; they liked only him. When other men came they ran away, but the flea went with them. He

[45] *Ibid.*, p. 598 (1925).
[46] *Ibid.*, p. 778 (1925).
[47] Kroeber, A. L., Univ. Calif. Pub., *Am. Arch. Eth.*, vol. 4, pp. 213–214 (1906–1907).

married all five. Now he turned into a flea, and in summer became sick with the itch. The girls did not like him any longer. They said, 'Let us run away. Where shall we go?' Then they agreed to go east together. 'When shall we go?' they said. 'As soon as he sleeps.' Now the flea slept and the five got up and went off. After they were far away the flea woke up and thought, 'Where are my wives?' He found that they had gone away. He thought, 'Where shall I go?' He went east. At last he came in sight of them, just before he reached the ocean. He said, 'I will catch you.' They said, 'He is coming. Let us go on.' They ran on again. Then one asked, 'Do you see him again?' Another said, 'Yes, he is near.' Then they said, 'Let us go up into the air. Then he cannot come with us.' Then they went up. But the man rose too. That is why there are five stars close together now in the Pleiades and one at the side. That one is he, the flea."

Fleas and the creation of man—Portion of a Wappo legend.[48] "They slept there and the next morning chicken-hawk said, 'Grandfather, the people are not moving.' '*Tsia'o, tsia'o,*' said coyote. Then he went to old man moon. When he got there, moon said, 'Well?' 'I've come for some fleas,' said coyote. Then he put them in a bag and tied the end of it. 'Here,' said the moon. Then coyote packed the bag on his back, opened it in the sweat-house, and poured out the fleas. They bit the people and they moved."

Carabid and tenebrionid beetles—Youelmani Yokuts—From Myth of Coyote's Adventures, etc. "Then he (coyote) said, 'I have *bododiwat* (small black ill-smelling beetles) inside of me. I have good meat in my belly. I will mix my food. . . . Soon he was taken with colic. He defecated. Then he saw the *bododiwat* and laughed. He said, 'There is my good mixed meat.' Soon he defecated again. He laughed again at seeing the beetles. 'There is that good meat. I am well now. I have put it outside of me. I will not be mixed any more.' "[49]

Many other legends, which treat of insects in various interesting ways, might be quoted, but from the few examples given it is clear that these small animals formed an important part in the life and knowledge of the Indians. It is only to be regretted that practically all of this information has perished with the different tribes.

[48] Radin, Paul. Univ. Calif. Press, Univ. Calif. Pub. in *Am. Arch. & Ethn.* (1), vol. 19, p. 45 (1924).
[49] Kroeber, A. L., Univ. Calif. Pub., *Am. Arch. Eth.*, vol. 4, p. 235 (1906–1907).

A FEW COMMON NAMES OF INSECTS IN VARIOUS INDIAN DIALECTS[50]

Pomo

ENGLISH	NORTHERN	CENTRAL	EASTERN	SOUTHERN	S. WESTERN	S. EASTERN	N. EASTERN
louse	tcī	tcī	gī	atcī	a'tcī	kalīūtciū	tī-ka
flea	ēmala	mala	beremal	ēmēla	īmēla	mīl	tūtūnū-ka
mosquito	tsamō-bitamta	tsumūl	dūladūla	malala	kotai	yūbe	ahakōlōi-ka
grass-hopper	cakō	cakō	cag'ō	cakō	ca'ko	xkōt	sakō-ka
yellow jacket	tcōō	tcōo	xalō	tcōo	djōo	kōōl	toō-ka
butterfly	kacaicai, ūlto	lilawa	xacaicai	alanta	tsa'da	sīlaxōtai	

Moquelumnan

ENGLISH	WESTERN	SOUTHERN	NORTHERN
louse	ket	tcūpsi	ket
flea	kûkû	kūkūs	kûkû
mosquito	soiyō	soiyō	sōiyō
grasshopper	kotok	koto	kōtō
yellow jacket	menanī	menanī	mēnanī
butterfly	kītīlak	kītīlyas	

Yuki

ENGLISH	WAPPO	HUCHNOM	YUKI	COAST
louse	hī	īk	īk	ik'e
flea	tcōte	t'ok	t'ok	t'ok
mosquito	stot	tcōōptcale	tcōptcalû	
grasshopper	tsī	latcoam	latcam	lātc'em
yellow jacket	neū	naaū	naam	naan
butterfly	tselekape	palpool	palkool	

Wintun

ENGLISH	SOUTHERLY	NORTHERLY
louse	peri	dōnō
flea	tcōtco	kōk'as
mosquito	tōsak	tcūcak
grasshopper	taram	nep
yellow jacket	lōnō	perem
butterfly	hosōlai	

Miwok

ENGLISH	PLAINS	AMADOR	TUOLUMNE	MARIPOSA	COAST
louse	ken	ketu	ketu, tcupsī	ketu, lupsi	ket
flea	kûkû	kukusu	kukusu	kuku	kûkû
mosquito	uygugu	uyukusu	uyukusu	tculu	soiyō
grasshopper	kodjo	kotco	kotco	añut	koto
yellow jacket	sūsū	melñaiû	melñaiu	melñai	menanī

[50] Barret, S. A., Univ. Calif. Pub., *Am. Arch. Eth.*, vol. 6, pp. 63, 76, 85, 366. (1908).

CHAPTER III

HISTORICAL BACKGROUND

It is impossible to give a detailed account of the historical influences on the development of entomology in this country. The agricultural development of a great new continent like North America brought forth many new problems in insect control not experienced in old world methods. The rapid evolution of specialized agriculture, in which large areas were devoted to a single crop

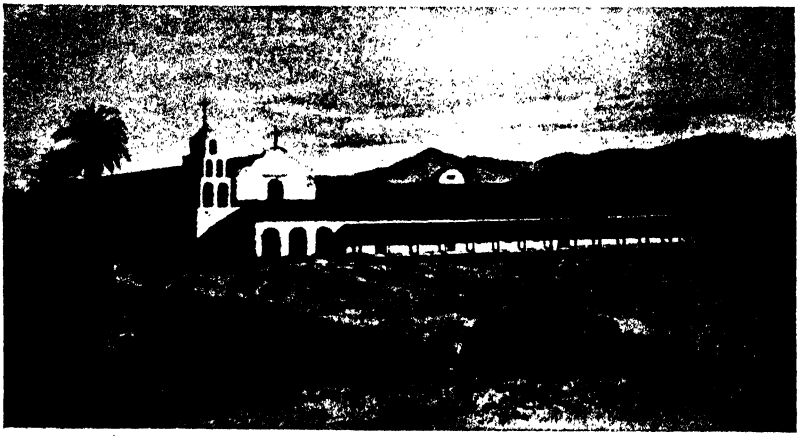

FIG. 38.—The Mission San Diego, the first of the twenty-one missions in California, established by the Franciscans July 16, 1769, as it appeared during the gold rush days of 1849.

such as tobacco, wheat, corn, cotton, potatoes, clover, apples and other deciduous fruits, citrus fruits, alfalfa, beans, peas and numerous other crops, created unusual opportunities for the excessive development of both native and introduced insect pests. The chinch bug, Colorado potato beetle, grape phylloxera, plum curculio, corn earworm, and various migratory grasshoppers are fair examples of native insects, while the cotton boll weevil, Mexican bean beetle, codling moth, European corn borer, Japanese beetle, alfalfa weevil, citrus scales, and many other equally obnoxious pests, illustrate the potentialities of foreign invaders.

The progress of these developments is well known to most entomologists, especially in so far as the area east of the Rocky Mountains is concerned. Along the Pacific Coast, however, it is more obscure and it is the purpose of these few pages to outline the progress of history in relation to the development of entomology, particularly in California.[1]

As has already been stated in Chapter II, there was no native agriculture in California or anywhere in the Pacific Coast region north of Lower California. The establishment, growth, and progress of agriculture and allied sciences may be divided into a number of more or less distinct periods as indicated in the following headings:

The Spanish or Mission Period, 1769–1877

Agriculture on the Pacific Coast of the United States began with the establishment of the Mission San Diego (Fig. 38) by the Spanish in 1769 and continued in a more or less prosperous manner in California until the end of the secularization of the missions in 1834. Pasturage was the great industry and the small gardens of varied fruits and vegetables were largely produced from seed, with the result that few agricultural insects were introduced during this early era.

Among the early introductions of insect pests it appears certain that the granary weevil, *Sitophilus granarius* (Linn.), and the rice weevil, *S. oryzæ* (Linn.), were brought along with the cereals used for food and for seed, since these insects are known to have been present in the older settlements of Lower California.[2]

The bean weevil, *Mylabris obtectus* (Say), must have also been introduced during the early part of the Spanish occupation.

Lice and fleas were abundant among the Indians and common in the Spanish settlements.

The ships which transported supplies and livestock carried to our shores the housefly, *Musca domestica* (Linn.); the stable fly, *Stomoxys calcitrans* (Linn.); the bluebottle flies, *Calliphora erythrocephala* (Meigen), and *C. vomitoria* (Linn.); the greenbottle flies, *Lucilia sericata* (Meigen) and *L. cæsar* (Linn.); the black blowfly, *Phormia regina* Meigen; and the tropical blowfly, *Paralucilia fulvipes* Macquardt (*Chrysomyia wheeleri* Hough). The carabid

[1] The chronological table in the last chapter gives a more detailed account of the historical aspects of the subject.

[2] Essig, E. O., *Some insects from the adobe walls of the old missions of Lower California*, Pan-Pacific Entom., vol. 3, p. 194 (1927).

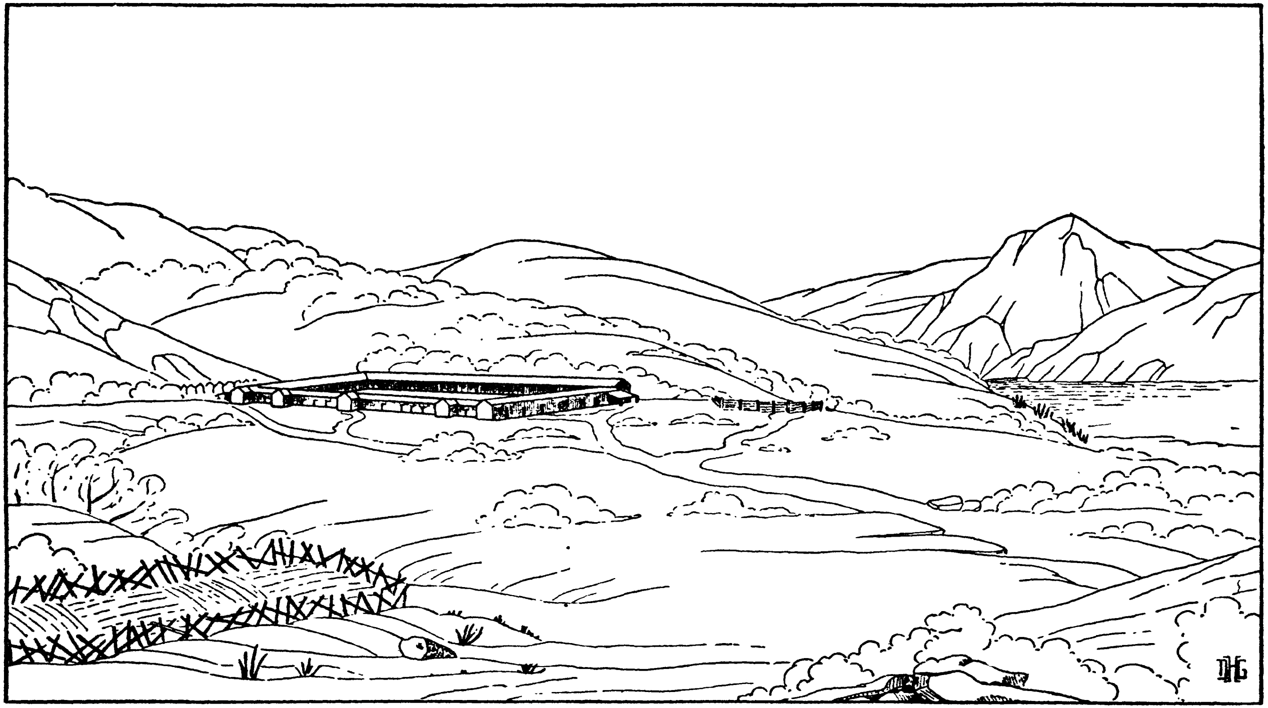

FIG. 39.—The Presidio of San Francisco as given by Louis Choris in 1822. This was the collecting ground where many California plants and animals were taken and especially those by A. Chamisso and J. F. Eschscholtz. The California poppy was taken here in October, 1816. (Redrawn from Choris.)

beetle, *Pristonychus complanatus* Dejean, was carried from Europe to Lower California and to California as far north as San Francisco Bay.

Later whaling, fur, and hide and tallow ships added generous entomological contributions including the red-legged ham beetle, *Necrobia rufipes* (DeGeer); the buffalo carpet beetle, *Anthrenus scrophulariæ* (Linn.); the larder beetle, *Dermestes lardarius* Linn.; the hide and tallow dermestids, *Dermestes marmoratus* Say and *D. vulpinus* Fabr.; the white-marked spider beetle, *Ptinus fur* Linn.; and many other insects which breed in excrement, dried animal matter, and cereals.

The Spanish made no other contributions to entomology on the Pacific Coast. They did not introduce the honeybee or make any collections or studies of insects in the new country.

The Russian Period, 1812–1841

The Russians became interested in the north Pacific Coast as a fur hunting and trading country and in California also as a possible place for producing agricultural necessities. Fort Ross (Fig. 40), established on the coast seventy-five miles north of San Francisco in 1812, as an agricultural development to produce wheat and vegetables, proved to be a valuable early entomological center and type locality of Coleoptera. Many naturalists from Russia visited this settlement and collected beetles which were taken to Europe and were later described by many different entomologists. Among the important collectors were J. F. Eschscholtz, who twice visited California with Otto von Kotzebue, in October, 1816, and in September and October, 1824. He collected many insects which were later described by him and after his death by P. F. M. A. Dejean; F. P. Wrangell, Governor of Russian America; F. Fischer, a physician of the Russian American Company; E. L. Blaschke, also a physician of the company; Tschernikh, an agriculturist in charge of one of the large farms operated near Bodega Bay; and I. G. Vosnesensky, naturalist and collector, sent out by the Academy of Natural Sciences, St. Petersburg. Many of the common beetles of the west coast were collected by these pioneer Russians. Due to the continued antagonism of the Spanish, the Russians abandoned Fort Ross in December, 1841.[3]

[3] For a fuller account of the Russian entomological activities in the West, see the biographical sketches of the above mentioned naturalists and collectors.

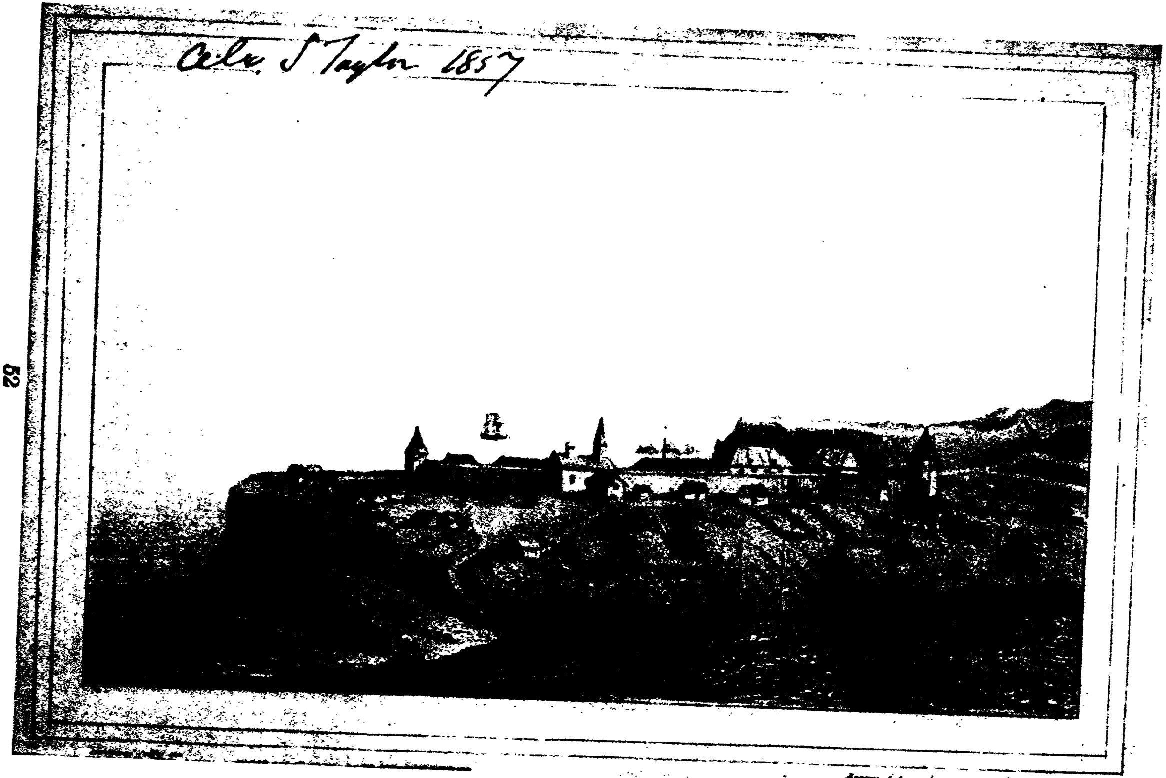

FIG. 40.—The Russian settlement Ross, commonly known as Fort Ross, as drawn by the Frenchman, A. Duhaut-Cilly, on June 4, 1828. This is the only authoritative early sketch of the place and is further interesting because it is from a book originally the property of Alexander S. Taylor, Monterey, California, whose signature appears at the top, and who also wrote an early important article on grasshoppers in the western states, parts of which are quoted elsewhere in this book. (After Duhaut-Cilly, 1835.)

The Early Period of American Occupation, 1848–1870

During the mad rush for gold, following the discovery of the precious metal in 1848, the most outstanding entomological contributions were made in California by the Frenchman, P. J. M. Lorquin, who collected Lepidoptera throughout much of the state. He took in all at least ninety-five species of which eighty-three were butterflies and twelve moths. These were forwarded to the celebrated French entomologist, J. A. Boisduval, who described fifty-three of the butterflies and nine of the moths as new species. A few specimens, taken by Lorquin, were also described by Edw. Doubleday, H. H. Behr, A. Guenée, and A. R. Grote and C. T. Robinson.[4]

With the completion of the transcontinental railroad in 1869 fruit culture soon became the paramount agricultural interest in California. The introduction of nursery stock and importations of ornamental plants from all parts of the world resulted in the establishment of many very serious pests and paved the way for the entomological activities described in the following chapters.

[4] See biographical sketch of Lorquin.

CHAPTER IV

PRINCIPAL INSTITUTIONS IN CALIFORNIA FEATURING ENTOMOLOGY

The earliest entomological activities of the white race in California do not go back very far. The Spanish began the introduction of the first injurious insects with the founding of the Mission San Diego in 1769, but they were in no way interested in the collecting and studying of these small pestiferous animals.

What appears to be the first insect taken from the Pacific coast by anyone interested in natural history was the beetle, *Carabus tædatus* Fabr., collected along the Alaska coast by the naturalist of the third voyage of James Cook in 1778. This beetle, deposited in the British Museum, was described by Fabricius in 1806.

In 1824 the hide ships began operating along the coast of California and distributed many insects at the various ports of call.

Following the Russian settlement at Fort Ross in 1812 a number of Russian naturalists visited the San Francisco Bay Region and the coast from Bodega Bay to Fort Ross and collected insects, chiefly Coleoptera.

Following the American occupation in 1850 the natural sciences were rapidly developed under institutional guidance and soon brought the new sciences up to a par with those east of the Rocky Mountains. First of these institutions was the California Academy of Natural Sciences organized in 1853.

The California Academy of Sciences.[1] The first meeting to consider the organization of an academy of sciences in California was held in San Francisco on April 4, 1853, at the office of Lewis W. Sloat at what was 129 Montgomery Street, between Sacramento and Commercial Streets. Seven scientists of note were present. On Monday, May 16, a proposed constitution, by-laws, and the name The California Academy of Natural Sciences, were adopted and on

[1] See Reports of the President of the Academy and Director of the Museum in the *Proceedings*.
Grunsky, C. E., *Historical account*, Proc. Calif. Acad. Sci. (4), vol. 6, pp. 230–233 (1917).
Gunder, J. D., *Entom. News*, vol. 40, pp. 101–105, pl. V (1929).

May 23d officers were elected. On June 13, 1868, the name was changed to its present form. The academy was first located at California and Dupont Streets. On September 29, 1875, the Market Street property, estimated to be worth more than a million

FIG. 41.—Ruins of the California Academy of Sciences following the earthquake and fire after April 18, 1906. The arrow indicates the entrance to the original building. The newer addition in the rear did not fall, but was completely fireswept. The Academy was then located on Market Street, between Fourth and Fifth Streets, and was erected in 1891. (After W. G. Wright, Entomological News, 1918.)

dollars in 1915, was unconditionally deeded to the Academy by James Lick. Later gifts by Charles Crocker, $20,000 in 1881, John W. Hendrie, $10,000 in 1899, and by Wm. Alvord, $5,000 greatly aided the institution.

A building was erected on the Market Street property between Fourth and Fifth Streets in 1891 which served until the earthquake and fire demolished it in 1906 (Fig. 41). The new building in Golden Gate Park was finished in 1915 and has provided modern, fireproof quarters for the very valuable collections and exhibits housed therein.

The interest in insects was early developed through the ability and efforts of H. H. Behr, who was appointed curator in charge of

the newly created department of entomology in 1862. Since then the curators have been

1862–1867	H. H. Behr, lepidopterist
1868–1880	R. H. Stretch, "
1881–1904	H. H. Behr, "
1904–1916	E. C. Van Dyke, coleopterist (Honorary curator of insects)
1910–1914	Carl Fuchs, Assistant curator, coleopterist
1916–to date	E. P. Van Duzee, hemipterist
1922–	F. R. Cole, curator of Diptera, dipterist

The Entomological collections of the Academy before the fire consisted of:

(1) Those made by W. Bryant and Gustav Eisen on the Academy's expeditions to Lower California in the years 1892, 1893, and 1894.

Fortunately the types of Coleoptera, described by G. H. Horn, were saved by Carl Fuchs, who personally carried them to a place of safety when the fire threatened the Academy building.

(2) H. H. Behr collection of Lepidoptera. The largest and finest single collection of insects in the Academy. It contained many types and paratypes. Fortunately duplicate paratypes of many of Behr's types, which were destroyed by the earthquake and fire in 1906, are preserved in the Strecker collection of Lepidoptera at the Field Museum, Chicago.

(3) H. Schött collection of Collembola, which contained types of many of the common California species.

(4) Carl Fuchs' collection of Coleoptera.

(5) The general collections of the Academy taken by many of the enthusiastic entomological members, including Hymenoptera by C. L. Fox.

All of these collections with the exception only of the Horn types of Coleoptera and of Fox's types of Hymenoptera and Uhler's types of Hemiptera, were completely destroyed in the fire following the earthquake on April 18, 1906.

New headquarters of the Academy were established in the Security Building on Market Street and the acquiring of new collections begun. Among the entomological collections donated to the Academy during this interim, the most important was the W. G. Wright collection of butterflies of the West Coast numbering from 6000 to 7000 specimens. The butterfly collections of E. J. Newcomer of California butterflies, and F. X. Williams from 600–700 California butterflies, were also acquired at this time. A second collection of Coleoptera gathered by Carl Fuchs was deposited in the Academy by Mrs. Fuchs, awaiting purchase, in 1914. Small collections of insects were donated by Mrs. R. H. Beck, John I. Carlson, Bruce Martin and many of the older entomological members.

Although the new fireproof and modern Academy building in Golden Gate Park was occupied late in 1915, it was not formally dedicated until September 22, 1916. Since that time the entomological collections have increased rapidly. From 10,000 to

FIG. 42.—A view of a portion of the entomological room in the California Academy of Sciences, Golden Gate Park, San Francisco. Those present, beginning in front, are James E. Cottle, lepidopterist; H. E. Burke, forest entomologist; E. C. Van Dyke, coleopterist and teacher of entomology; and E. P. Van Duzee, hemipterist and curator of insects of the academy. The large portrait of J. J. Rivers and the small one of W. G. Wright are also to be seen. The crowded condition will be relieved upon the completion of a new wing now under construction. A magnificent collection of insects has been assembled here. (Photograph from J. G. Gunder taken by G. Moulin, April 29, 1929.)

20,000 specimens of miscellaneous insects were annually added by the members of the entomological staff and of the Academy (Fig. 42). In addition to these the following large and important private collections were presented to the Academy:

1915 E. P. Van Duzee Collection of Hemiptera.
30,000 specimens.

1924 H. M. Holbrook Collection of Lepidoptera.
500, mostly tropical butterflies.

1924 E. C. Van Dyke Collection of Coleoptera.
100,000 specimens in all families. Especially rich in Carabidæ, Elateridæ, Buprestidæ, and Cerambycidæ.

1925 F. E. Blaisdell Collection of Coleoptera.
100,000 specimens in all families. Especially rich in Tenebrionidæ and Melyridæ.

1926 A. Kœbele Collection of Insects.
100,000 specimens in many orders. Presented by Mrs. Kœbele as a memorial to her husband.

1927 Louis S. Slevin Collection of Coleoptera.
Collected in the vicinity of Carmel, California.

1928 C. L. Fox Collection of Hymenoptera.
16,000 specimens.

In the Proceedings published by the Academy have appeared very many important papers on insects, some of which are referred to in the biographical sketches of Chapter IX.

The Academy also financially aided in publishing the Pan-Pacific Entomologist started in July, 1924, with E. P. Van Duzee as the editor.

University of California.[2] The University of California was founded in 1868 and a professor of agriculture, agricultural and applied chemistry and horticulture was elected in 1869.[3] On August 11, 1874, E. W. Hilgard was elected to the professorship and at once began to lay the foundations for the various types of agricultural investigations and teaching which rapidly developed under his leadership. An experiment station was established during the same year,[4] but funds from the provisions of the Hatch Act for

[2] Wickson, E. J., *Beginnings of agricultural education and research in California*, Univ. Calif. College of Agr. and Agr. Expt. Sta., Rept., July 1, 1917–June 30, 1928, pp. 35–101 (1918) (Entomology, pp. 35–101).

Also see the reports of the College of Agriculture and the Agricultural Experiment Station.

[3] The first professor was Ezra S. Carr, who held the position from 1869 to 1874, when he was succeeded by E. W. Hilgard.

[4] When the College of Agriculture of the University of California was organized it was understood that a part of its work would consist of experimental inquiries. In 1870 E. S. Carr, in an address at the State fair, stated that "the University proposes to furnish the facilities for all needful experiments; to be the station where tests can be made of whatever claims attention." The university grounds at Berkeley were developed with reference to their use for experimental purposes, and in 1874 a considerable number of varieties of grapes and orchard and small fruits were planted, and a barn and two propagating houses were built. The same year Hilgard was chosen professor of agriculture. Professor Hilgard had previously been engaged for a number of years in conducting an agricultural and geological survey in Mississippi, in connection with which chemical examinations of soils, field experiments, and other agricultural investigations had been incidentally carried on in accordance with a plan inaugurated as early as 1857 and afterwards made the basis for the highly successful work of the California experi-

the establishment of the official agricultural experiment station, were not available until March, 1888.

In entomology several serious problems demanded attention. The fact that the codling moth had been actually found in apples

FIG. 43.—The entomological laboratory of Professor C. W. Woodworth, Agricultural Hall, University of California, in 1900. The room was put in order for a special evening entertainment and an inspection of the equipment and the insect collections. Portions of the R. H. Stretch and the J. J. Rivers collections are on the tables at the right. The attention is attracted to the coal stove, the gas illuminators for the microscopes, and the impeccable kitchen tables.

exhibited at the San Joaquin Valley Fair, held in Stockton in 1874 and the grape phylloxera was discovered the same year in the largest vineyard of the state at Sonoma, was a terrible blow to the equilibrium of the horticultural and viticultural interests of the state. Hilgard was greatly impressed with the importance of

ment station, which has been continued under his direction for a quarter of a century. "In the winter of 1875–76 the first field experiments were undertaken to determine the effects of deep culture and of the application of various fertilizers. In 1875 the laboratory branch of the experiment station work was inaugurated, the regents making provision for the expenses thereof for the first two years, and at the end of this time the legislature opened the way for the continuation and extension of the work by liberal special appropriations from year to year."—True, A. C., U. S. Dept. Agr., *Yearbook*, 1899, pp. 514–515 (1900).

the phylloxera situation and personally investigated the infested vineyard, wrote press articles [5] and a university bulletin [6] relating to the insect, and because he could not otherwise secure interest and action from the grape growers, he called and addressed a meeting at Sonoma, Saturday, November 23 (1878).[7] To further this cause he detailed F. W. Morse, a college chemist, to begin field studies of the insect in 1878.

During this interim Hilgard also lectured on general entomology to students at the college and at farmers' meetings in various parts of the state.

The discovery of the San José scale and other scale insects on deciduous fruit trees in the Santa Clara Valley prior to 1880, as well as the seriousness of the various new coccids introduced into the citrus orchards of southern California, added to the growing interest in the importance of economic entomology. As there were no trained entomologists in California at this time there came an urgent demand for expert advice. Accordingly in March, 1881, the California Board of State Viticultural Commissioners sent a resolution to the Regents of the University of California asking for the appointment of a professor of entomology.[8] This resolution was repeated at a meeting of the same board held in San José, April 2 of the same year.[9] The request was granted by the Board of Regents on the condition that the State Legislature appropriate $2000 annually for the same. This the Legislature failed to do in 1881.

In 1882 special instruction in entomology to students in the College of Agriculture was begun by C. H. Dwinelle, a lecturer on practical agriculture and entomology and supervisor of field experiments in the College of Agriculture, " at the rate of one exercise per week. " In 1884 he published a bulletin on the subject.[10] As it gives a splendid idea of the attitude towards entomology at this early period in the history of the agricultural development of the state it is given herewith in full:

[5] *Pacific Rural Press*, vol. 10, p. 275 (October 30, 1875); vol. 12, p. 58 (July 22, 1876).

[6] *Univ. of Calif. Bul. 23* (Jan., 1876) revised and republished in 1880.

[7] *Pacific Rural Press*, vol. 16, p. 338 (November 30, 1878).

[8] *Pacific Rural Press*, vol. 21, p. 206 (March 19, 1881).

[9] *Ibid.*, p. 263 (April 9, 1881).

[10] *Entomology in the College of Agriculture*, Calif. Agr. Expt. Sta., Bul. 16 (Sept. 11, 1884).

Entomology in the College of Agriculture

The study of Entomology has been gradually given a place in the College of Agriculture as a matter of necessity, to meet the pressing needs of the State. Several years since, numerous inquiries from those engaged in various branches of agriculture showed the want of a more definite knowledge of insects and their habits, and of methods of combating those which are noxious. These were met as fully as could be by correspondence, and by publications in pamphlet form, or in newspapers.

In this direction have been Professor Hilgard's pamphlet on the Phylloxera, with full illustrations, published in 1880, and the writer's contributions to the First Report of the Board of State Horticultural Commissioners, 1882. Mr. F. W. Morse, Analytical Assistant for the College of Agriculture, has for several years made a special study of the Phylloxera, and has been repeatedly employed by the Board of State Viticultural Commissioners to examine and report upon the spread of that pest in California.

The various members of the College Faculty have also, from time to time, prepared papers and addresses upon entomological subjects, for presentation before horticultural and viticultural societies and conventions, and by conversation with individuals visiting the University, or met during expeditions into the country, have done what they could to disseminate knowledge upon this important subject.

Instructions to Students

Seeing the importance of a close acquaintance with insects, injurious and beneficial, to the coming farmers of California, the writer undertook, in addition to the work for which he was engaged, to give a limited course in General and Economic Entomology to students in the College of Agriculture, and such others as might wish to join the class. This was at first experimental, but it so far met the approval of the students, and the Faculty of the University, that the study was made one of the regular requirements for Junior year in the College of Agriculture. Our experience up to this time has shown that more extended work should be done in this department by a professional entomologist.

Contributions Received

The College of Agriculture acknowledges valuable aid in time past from public spirited citizens, who have contributed liberally to strengthen its entomological resources. The Ricksecker collection of several thousand specimens of beetles was purchased at a cost of $400, donated by Capt. J. M. McDonald, of San Francisco, Mr. Matthew Cooke, of Sacramento, and Mr. Cutler Paige, of San Francisco. Considerable clerical work, etc., was paid for by various sums given during the years 1881 and '82 by the following named gentlemen: R. B. Blowers, J. D. Stevens, A. T. Hatch, John Rock, Jas. Shinn, W. W. Smith, W. H. Jessup, M. T. Brewer & Co., and E. T. Earl.

Preparation for Teachers

There is a very strong feeling growing up that some instruction in the elements of entomology should be given in our public schools. Until there is a

more general understanding of the nature of insects and the ways in which they are spread from place to place, there can be little hope of that general co-operation which is essential in all successful efforts to keep them within bounds.

At the State Fruit Growers' Convention held in San Francisco in November, 1883, the following resolution was adopted:

"Whereas, The fruit and vine interests bid fair to become the leading industries of this State,

"Resolved, That we, in convention assembled, as representing the fruit growers of this State, do urgently and earnestly request, pray, and by right demand, the introduction into our public schools of the study of Economic Entomology."

Endowment of a Professorship

The tillers of the soil are by no means the only class of our citizens who are beginning to realize the immense losses which yearly take place through the ravages of insects. Dealers in animal and vegetable products, raw or manufactured, have these tiny robbers too often brought to mind. Considering the enhanced cost of things which they attack, we may safely claim that every one is interested in the question of their control.

At the convention above mentioned the writer presented a paper upon The Need of a General Knowledge of Insects, and proposed that the want should be met by providing the funds necessary to enable the Regents of this University to fill the Chair of Entomology, which they established several years ago. The following words were used: "We ought to have a thorough entomologist to teach entomology to our horticulturists and agriculturists generally, and to those who are to become teachers themselves, as a large number of graduates take that course." "We want the very best man that can be had, . . . who is in the prime of life, so that he has many good years of valuable service to give us, and who will come here with the understanding that he is to be an instructor in entomology as his great work . . . and who will devote himself in every way to advancing entomological instruction, and will act for the good of the whole State, beginning, of course, at home. . . . The State has done a great deal for the University of California, and I believe it is a proper thing just at this juncture for those who specially want general information on the subject of entomology, to be used in the line of their business, to put their hands in their pockets, and it is probably a very serious question whether it would not be the very best investment they could make, and put a few hundred, or a thousand, or five or ten thousand, according as they have been prospered, into an endowment of this chair." "I see gentlemen here who could well have afforded to have done that ten years ago." "It would have been thousands of dollars in their pockets, and I do not think they will question my figures." "I have known of their spending $1,500 in a month, in fighting their pests, which they and their neighbors ought to have known all about, and to have stamped out in their incipiency." "Now, this is a serious matter, and I hope that you will give it the most serious consideration. . . . I bring forward to you, gentlemen, a practical proposition for the good of the State, not only in future generations, but within your own time."

The proposition was strongly approved of by Prof. E. W. Hilgard of the State University, Mr. Matthew Cooke, Dr. S. F. Chapin, and others, and indorsed by vote of the convention.

The following committee was appointed to consider the proposed endowment, and to solicit contributions towards it: C. H. Dwinelle, University of California; Hon. William Johnston, Richland; Dr. S. F. Chapin, State Inspector of Fruit Pests; Matthew Cooke, Ex-chief Horticultural Officer; A. T. Hatch, Cordelia; E. J. Wickson, Editor Pacific Rural Press.

The committee estimate the sum needed at fifty thousand dollars ($50,000), a small amount when the interests affected are considered.

Enough money has already been promised to make a respectable nucleus, and all who are inclined to help on the good work, should report at once to some member of the committee.

C. H. Dwinelle.

Berkeley, Sept. 11, 1884.

In 1884 and 1885 also Hilgard [11] reviewed the phylloxera remedy of J. A. Bauer and Morse [12] published the results of his observations on the insect made during 1884. In view of the real needs for teaching and research work in entomology, Hilgard urged the appointment of an entomologist to the staff of the College of Agriculture in 1886, but to no avail. He did his part, however, by publishing two bulletins, one on alkaline washes and one on whale oil soap, as insecticides for fruit trees.[13] At this time (1878–1886), also, he employed W. G. Klee, subsequently appointed Inspector of Fruit Pests by the California State Board of Horticulture, who issued a bulletin on the control of the woolly apple aphis in 1886.[14]

E. J. Wickson [15] graphically records the developments in this field and I am using his own language in relating many of the facts in the historical development from 1886 until 1903.

In 1886 Wickson tested more than one hundred varieties of wheats in their relation to the resistance of the Hessian fly [16] which work was continued until 1887.[17] "In 1887 analyses of insecticides were undertaken and public warnings of adulterations given . . . and orchard demonstrations of degree of efficiency of band treatment against the codling moth undertaken and pursued to publication" by Wickson.[18] "This was counted by the United

[11] *Univ. Calif. Bul. 18* (Oct., 1884); *Bul. 48* (Nov., 1885).
[12] *Ibid., Bul. 19* (Oct., 1884).
[13] *Univ. Calif. Bul. 52* (Feb., 1886); *Bul. 56* (May, 1886).
[14] *The woolly apple aphis and its repression, ibid.*, Bul. 55 (May, 1886).
[15] *Op. cit.*, pp. 84–86 (1918).
[16] *Univ. Calif. Bul. 58* (Oct., 1886); *Rept. 1890*, p. 312.
[17] *Ibid., Bul. 72* (Aug., 1887).
[18] *Ibid., Bul. 75* (Nov., 1887); *Rept. 1890*, p. 308.

States Entomologist (C. V. Riley) in his report for 1887 as 'the only attempt with which we are familiar to tabulate the exact proportions between the worms on a tree and those caught by the bands.' In 1887, also, an elaborate experiment was pursued in spraying with paris green and other arsenicals for the codling moth, 71 per cent of apples and pears being saved from intrusion, without injury to foliage or poisoning of fruit, as analysis demonstrated. On the basis of this local demonstration California growers took up this new eastern method of protection, which they had previously feared, thinking the lack of rains would allow the poison to remain in place.

"In 1887 the station, at the urgent request of San Gabriel orange growers, undertook investigation of the feasibility of destroying scale insects on citrus trees by fumigation, a process for which private parties proposed to exact royalties, and after trying many gases, a station chemist [19] made public proclamation of the availability of hydrocyanic acid gas. This happened to be the discovery upon which the profiteers proposed to proceed and their proposition was gasbombed thereby. Subsequently fumigation investigations were pursued by the station entomologist for twenty years and notable contributions made to understanding of the agency and introduction of improved methods of application.[20]

"By statute of March 15, 1887, the California Legislature required the teaching of economic entomology in the public schools, and was the first state to require entomology except as included in general courses on zoölogy.

"This requirement was made by the Legislature at the earnest solicitation of the fruit growers, who claimed that teaching children to recognize injurious insects, and to understand something of their life-history, would be the most direct and expeditious." To assist school teachers Prof. Wickson [21] offered the following suggestions:

1. Teachers must be trained in entomology.
2. Schools should have books and microscopes.
3. Methods of controlling injurious insects should be obtained from local county horticultural commissioners and well-informed orchardists.
4. Instruction should be given with the actual specimens in the hands of the pupils at the time.
5. Because of the size, scope and difficulty of the subject it is not advisable to attempt much in the way of classification.
6. The teacher should stimulate students to collect and study insects outside of the class room and thus also interest the parents.

[19] Morse, F. W., *The use of hydrocyanic acid against scale insects*, *ibid.*, Bul. 73 (Aug., 1887).

Experiments on the cause and avoidance of injury to foliage in hydrocyanic gas treatment of trees, *ibid.*, *Bul. 79* (May, 1888). There is little doubt but that Morse got his ideas about HCN fumigation from the work of Coquillett, Craw, and Wolfskill, the "profiteers" referred to by Wickson.

[20] See C. W. Woodworth, bibliography.

[21] Wickson, E. J., *op. cit.*, *Rept. 1890*, pp. 303–307 (1891).

7. Oral instruction direct from specimens preferable to textbooks.
8. Permanent collections of insects desirable.

There was only a half-hearted response to this new requirement. Teachers knew nothing about the subject and the only books available were the two by Matthew Cooke,[22] which were quite inadequate for school purposes. Cooke did print some special charts showing the different kinds of insects which proved to be much more useful for the teachers (Fig. 173).

"This requirement was repealed about five years later, but it had notably quickened public interest in crop protection and was the foundation of expanded voluntary effort which has endured to this time."

Following the passage of the Hatch Act in 1888, creating agricultural experiment stations throughout the country, California acted with such promptness as to have such funds available for the California Agricultural Experiment Station in March, 1888. In 1889 a new wooden building known as Agriculture Hall was erected on the University campus and gave the first adequate quarters for the College of Agriculture and the Experiment Station. In this year E. J. Wickson, Associate Professor of Agriculture, Horticulture and Entomology, gave a course in Economic Entomology [23] "in the absence of a specialist in the science. This course is quite numerously attended, as the direct result of the demand for information on the habits, and modes of repressing, insect pests." This instruction was continued until the appointment in May, 1891, of C. W. Woodworth as assistant in entomology in the Experiment Station and Assistant Professor of Entomology in the College of Agriculture and was the first trained entomologist to assume teaching duties in the state. For twenty-nine years thereafter he headed up the entomological activities in Entomology in the University of California.

"In 1892 the station entomologist published 'a key to detection of the cause of failure of seeds to grow or of plants to be thrifty through injurious insects or fungi,' [24] also a 'synopsis of families of insects to enable the unscientific public to determine characters of insects suspected of injury to plants.' " [25]

These publications were widely used in elementary instruction and by practical plant growers, and ministered to the expansion of popular interests in plant protection. In 1892 there was also published detailed account of a two-year experiment in spraying a collection of 200 varieties of apples and pears for scale insects, aphis and scab, which was early work of such breadth in that line,[26] and was followed for several years with full discussion of various remedies for scale insects and fungi.

[22] *A treatise on insects injurious to fruit and fruit trees in California*, Sacramento, 72 pp., 75 figs. (1881).

Injurious insects of the orchard, vineyard, etc., Sacramento, 472 pp., 368 figs. (1883).

[23] *Calif. Agr. Expt. Sta., Rept. 1889–1890*, p. 6 (1890).

[24] Woodworth, C. W., *A synopsis of the diseases of cultivated plants*, Calif. Agr. Expt. Sta., Rept., 1891–1892, pp. 258–270 (1892).

[25] Woodworth, C. W., *A synopsis of the orders and families of insects*, *ibid.*, pp. 271–312, fig. 3 (1892); also published separately; *Univ. Calif. Syllabus Ser. 13*, 12 pp. (1909).

[26] Woodworth, C. W., *California Agr. Expt. Sta., Rept. 1892–1893*, p. 441 (1893).

In 1897 Agricultural Hall burned to the basement and was immediately rebuilt. The name continued, however, until transferred to the present Agriculture Hall which was occupied in 1912. The old building was then rechristened Budd Hall.

" In 1901, the station urged insecticide control with such force that the Legislature passed the first ' Paris green law ' which was amended in 1903.[27] In that year one quarter of about twenty tons of Paris green offered for sale in the state was condemned, and of ninety samples submitted by purchasing growers fifty-three were condemned. In the following year very few samples were found unfit, so quickly did the law and the station compel the eastern manufacturers to revolutionize their practices. In 1906 [28] only one seventh of the materials offered for sale were found defective. In 1911 a broader insecticide control law was passed by the Legislature, and the work expanded with great elaboration and beneficent results, beyond the reach of this sketch.

"In 1903 coöperative investigation and executive control of insects with counties and social organizations was begun and found very productive, notably in the case of apple growing in the Watsonville [29] and San José districts. In 1903 also mosquito control [30] was coöperatively entered upon and pushed widely by practical demonstrations and publications. Wide coöperation was also pursued in grasshopper control and in suppression of the Argentine ant, the house fly and other menaces to public health.

"In 1906 the enlargement of the University Gymnasium required the displacement of an old wing which was sawn free and moved a little distance away. As it was standing with an open side and its upper floors propped up until time for demolition, the agricultural department acquired possession and by putting on a new face and a lot of partitions within, fitted it to house the division of entomology for several years. When this division was moved to new quarters in Agriculture Hall in 1912, the upper part of this old gymnasium fraction was given to the State Insecticide Laboratory, and the lower to the Pure Food Laboratory of the State Board of Health, and the building has continued in these services to this day.[31]

"It is impossible to characterize all the researches and publications in

[27] Colby, Geo., *Arsenical insecticides*, Calif. Agr. Expt. Sta., Bul. 151, 37 pp. (May, 1903).

[28] Colby, Geo., and Woodworth, C. W., *Analysis of Paris green and lead arsenic. Proposed insecticide law, ibid.*, Bul. 182, 8 pp. (Dec., 1906).

[29] This work was directed by C. W. Woodworth and results published in *Directions for spraying for the codling moth*, Calif. Agr. Expt. Sta., Bul. 155, 20 pp. (March, 1904).

[30] The organization of the first mosquito control campaign at Burlingame was accomplished in 1905 by H. J. Quayle and results of the work were published by him in a bulletin entitled *Mosquito Control, ibid.*, Bul. 178, 55 pp., 35 figs. (July, 1906).

[31] *Ibid.*, p. 46 (1918).

economic entomology which have established the basis for satisfactory knowledge of scores of pests and for effective procedure against them. Of these the treatments of the potato worm, the peach worm, the groups of vine insects, a notable series of monographs upon the several injurious insects of citrus trees, etc., constitute the greatest volume of close special study and dependable exposition which California has produced. Coincident with this achievement the division was progressively munitioned both for instruction and research by continued attention to collection and classification, and systematic experts provided therefor."

In 1920 W. B. Herms, Professor of Parasitology, was appointed head of the Division, the name of which was changed to Entomology and Parasitology.

The creation of various stations and branches of the College of Agriculture resulted in a division of the Entomological staff. With the establishment of the Whittier Plant Disease Laboratory and the Riverside Citrus Experiment Station in 1905, the entomological activities there have been largely in charge of H. J. Quayle who devoted much of his time to the study of insect pests in relation to citriculture. Both of these stations were replaced by the Citrus Experiment Station and Graduate School of Tropical Agriculture at Riverside in 1913. In addition to the existing insect investigations in the south the biological control work in charge of H. S. Smith and his associates was transferred to the Riverside station from the State Department of Agriculture in 1923.

At the northern branch of the College of Agriculture at Davis, certain members of the regular staff of the Division of Entomology were established there from time to time. L. J. Nickels gave instruction in general entomology and apiculture there in 1913, followed by G. A. Coleman, E. R. de Ong and other members of the staff since then. In 1922 G. H. Vansell took over the work there and the staff was augmented by the transfer from Berkeley of S. B. Freeborn in 1924 and F. H. Wymore in 1926.

In addition to the regular bulletins, circulars and reports of the Agricultural Experiment Station and College of Agriculture, the University of California Press established in 1906 the Entomology Technical Bulletins.[32] C. W. Woodworth was editor from the

[32] In this series the following volumes have so far appeared: vol. 1, 433 pp. (Sept., 1906–Nov. 21, 1922); vol. 2 (Catalogue of the Hemiptera of America North of Mexico, by E. P. Van Duzee), 902 pp. (Nov. 30, 1917); vol. 3, 460 pp. (Nov. 1, 1919–March 24, 1926); vol. 4, 383 pp. (Aug. 18, 1926–March 22, 1928); vol. 5 now being issued: At the beginning of volume 4 the title became *University of California Publications in Entomology*.

beginning of the series until 1920 since which time an editorial board consisting of three members [33] has had supervision of the publication.

Several insect collections were acquired by the Division of Entomology at various times. The first of these was the Ricksecker Collection consisting of several thousand specimens of beetles purchased from L. E. Ricksecker for the sum of $400 donated by J. M. McDonald of San Francisco, Matthew Cooke of Sacramento, and Cutler Paige of San Francisco in 1881.[34] Only a few specimens of this collection are now in existence.

The R. H. Stretch collection of Lepidoptera was donated to the University by R. H. Stretch in 1885. It contained approximately 5,000 specimens, mostly moths, some of which were destroyed by museum pests. In 1919 the entire collection was transferred as a loan to the California Academy of Sciences, San Francisco, where it is housed in new insect-proof containers.

During the three years, 1908–1911, that Carl Fuchs acted as curator of the entomological museum, he prepared quite an extensive collection representing partially the various insects originally described by Linnæus. This collection is still in existence.

At the present time insect collections are being worked up for teaching and reference purposes only. Some years ago it was decided to deposit all valuable specimens as well as types, paratypes, cotypes, etc., in the California Academy of Sciences. In 1917 Van Duzee presented his collection of Hemiptera to the Academy, Van Dyke followed with his very large collection of Coleoptera in 1924. Essig's and Kuwana's [35] types and paratypes of Aphididæ and Penny's [36] types of Aleyrodidæ were also presented to the Academy.

The Entomology Club was organized by the students and faculty in 1920 and has continued as a means of social and educational fellowship. It meets monthly during the school year at the homes of the faculty members.

[33] The members of the editorial board have been E. C. Van Dyke, Chairman, C. W. Woodworth, and E. O. Essig.

[34] Dwinelle, C. H., *Calif. State Bd. Hort., Bien. Rept.*, p. 102 (1884).

[35] Essig, E. O., and Kuwana, S. I., *Some Japanese Aphididæ*, Proc. Calif. Acad. Sci. (4), vol. 8, no. 3, pp. 35–112, figs. 1–40 (July 9, 1918).

[36] Penny, D. D., *Catalogue of California Aleyrodidæ, and the descriptions of four new species*, P. C. Jour. Entom. and Zoöl., vol. 14, pp. 21–35, 4 figs. (1922).

List of the Members of Division of Entomology in the University of California

C. W. Woodworth, Assistant in Entomology—Professor of Entomology 1891–1930
Entomologist in the Experiment Station 1891–1925
Head of Division of Entomology 1891–1920
Editor Entomology Technical Series, U. C. Publications 1906–1920
C. Fowler, Assistant in Entomology 1900–1901
W. T. Clarke, Field Assistant in Entomology 1902–1906
Geo. Colby, Assistant Chemist—Chemist in Insecticides 1902–1913
H. J. Quayle, Assistant in Entomology 1903–1905
Assistant Professor of Entomology—Professor of Entomology and Entomologist in the Experiment Station (Riverside) 1906–
R. Benton, Assistant in Entomology (Apiculture) 1906–1910
J. C. Bradley, Assistant in Entomology 1906–1907
Assistant Professor of Entomology (Exchange Professor from Cornell University) 1917–1918
W. B. Herms, Assistant Entomologist-Professor of Parasitology . . . 1908–
Entomologist in the Experiment Station and Head of the Division of Entomology 1920–
J. S. Hunter, Field Assistant in Entomology (San Mateo) 1908–1911
W. H. Volck, " " " " (Watsonville) 1908–1913
Earl Morris, " " " " (San José) 1908–1913
Carl Fuchs, Curator of the Entomological Museum 1908–1911
J. C. Bridwell, Assistant Entomologist 1910–1913
Anna Hamilton, Artist 1911
A. B. Shaw, Assistant in Entomology 1911–1913
Geo. P. Gray, Assistant Chemist—Chemist in Insecticides 1911–1920
E. W. Rust, Assistant in Entomology (Whittier) 1911–1912
Parasite Collector (South Africa) 1923–1928
M. R. Miller, Assistant Chemist in Insecticides 1912–1918
L. J. Nickels, Assistant in Entomology (Apiculture, Davis) 1913–1915
G. A. Coleman, Instructor in Entomology and Apiculture—Curator of the Agricultural Museum 1913–1922
E. C. Van Dyke, Instructor in Entomology—Professor of Entomology 1913–
Chairman Editorial Committee Entomology Technical Series, U. C. Publications 1920–
E. O. Essig, Instructor in Entomology—Professor of Entomology and Entomologist in the Experiment Station 1914–
S. B. Freeborn, Instructor in Entomology—Associate Professor of Entomology and Associate Entomologist in the Experiment Station 1914–
E. R. de Ong, Instructor in Entomology—Assistant Entomologist in the Experiment Station 1915–1927

E. P. Van Duzee, Instructor in Entomology.................... 1915–1917
A. F. Swain, Assistant in Entomology (Riverside)............... 1916–1919
H. H. P. Severin, Instructor in Entomology..................... 1916–1925
Assistant Entomologist—Associate Entomologist in the Experiment Station.................. 1916–
G. H. Vansell, Assistant in Entomology (Riverside).............. 1920
Instructor in Entomology—Associate in Entomology (Davis)................................... 1922–
H. Knight, Assistant in Entomology (Riverside)................ 1920–1925
J. F. Lamiman, Research Assistant in Entomology and Parasitology.. 1922–
H. S. Smith, Associate Professor of Entomology and Entomologist in the Experiment Station (Riverside)........................ 1923–
H. Compere, Assistant in Entomology (Riverside)............... 1923–
A. J. Basinger, Assistant in Entomology (Riverside).............. 1923–
F. H. Wymore, Research Assistant in Entomology and Parasitology —Associate in Entomology and Parasitology (Davis)........... 1923–
F. Silvestri, Entomological Explorer (China)................... 1924–1925
P. H. Timberlake, Assistant Professor of Entomology—Associate Entomologist in the Experiment Station (Riverside)............ 1924–
J. C. Chamberlin, Assistant in Entomology (Riverside)........... 1924–1926
A. D. Borden, Research Assistant in Entomology and Parasitology. 1926–
R. H. Smith, Assistant Entomologist—Associate Entomologist in the Experiment Station (Riverside)......................... 1926–
Jocelyn Tyler, Research Assistant in Entomology and Parasitology. 1926–
C. F. Henderson, Assistant in Entomology and Parasitology....... 1926–1929
L. M. Smith, Assistant in Entomology and Parasitology (San José). 1927–
A. C. Davis, Assistant in Entomology and Parasitology (Garden Grove)... 1927–
O. H. Lovell, Assistant in Entomology and Parasitology (San José). 1928–
A. M. Boyce, Junior Entomologist in the Experiment Station (Riverside)... 1927–
S. E. Flanders, Parasite Collector, Citrus Experiment Station (Riverside)... 1929–
W. M. Hoskins, Assistant Entomologist in the Experiment Station. 1929–

Stanford University.[37] Stanford University was founded in 1885. John Henry Comstock, Professor of Entomology at Cornell, was named professor of entomology at Stanford, spending the three winter months, January, February, and March of each year at Stanford, the rest of the time being spent at Cornell. In January, 1892, he made his first visit to the Stanford campus and offered lecture courses in general entomology and courses in classification, and also directed some laboratory work. He returned to Stanford again during the winters of 1893 and 1895, being absent on

[37] This historical account of the development of entomology at Stanford University was very generously prepared by Professor R. W. Doane.

leave during the winter of 1894. As far as I can learn Comstock offered no courses here after 1895, although his name appeared among the list of professors until 1900. Since that time he has visited Stanford at various times and has always expressed a lively interest in the affairs of the department. During his early years here he laid the foundations for the systematic and biological collections which have been developed since that time.

In September, 1892, Willis Grant Johnson was appointed assistant in entomology and served in that capacity throughout his whole year. Professor Johnson did not devote his whole time to entomology but acted as assistant registrar part of the time.

Vernon Lyman Kellogg was appointed assistant professor of entomology in September, 1893, but he did not begin his work here until the following year.

During the years 1893 and 1894 both Comstock and Kellogg were absent on leave and no courses were offered. In the fall of 1894 Kellogg took up his work here as associate professor of entomology. In 1895 he was made professor of entomology. The college year of 1897-1898 was spent in Europe by Kellogg. The courses that were offered during that year were given by William Appleton Snow, assistant in entomology, and by Robert Evans Snodgrass, laboratory assistant in zoölogy and entomology.

Beginning the college year of 1898-99, the courses in entomology were listed as courses in zoölogy, Kellogg still being in charge of the entomology and Snow and Snodgrass acting as instructors.

During the college year 1899-1900 we find Comstock still listed as one of the professors of the Department and although he was resident on the campus at that time no courses were scheduled as being given by him. The courses that year were given by Kellogg, Instructor Snow, and Assistant Snodgrass.

In the years 1900 and 1901 we find Comstock no longer listed among the faculty members. Snodgrass was made instructor in that year.

For the year 1901-02 we find Sinkai Inokichi Kuwana and Mary Wellman assistants in entomology.

The college year 1902-03, entomology again became a separate department with Kellogg as professor, Snodgrass as instructor, and Ruby Green Bell as assistant and E. B. Copeland became instructor in bionomics.

In 1903-04, Mary Isabel McCracken became assistant in bionomics and physiology and Ruby Green Bell became instructor in bionomics.

At the beginning of the college year 1904-05 the name of the department became Department of Entomology and Bionomics. During this year Kellogg was absent on leave. Snodgrass and Bell were instructors, and McCracken acting instructor.

At the beginning of the college year 1905-06 Rennie W. Doane became instructor and curator. McCracken was listed as instructor.

For the year 1906-07 the instructors consisted of Kellogg, professor; Doane, instructor and curator; McCracken, instructor and Mary C. Dickerson acting instructor in bionomics and Rose Paterson and Bertha Ametia Wiltz assistants.

For 1907–08 we find Robert Earl Richardson listed as instructor in bionomics, but he did not begin his work until September, 1908. The assistants for this year were W. F. Derby, F. X. Williams and Bertha A. Wiltz.

During the year 1908–09 Doane and McCracken were made assistant professors. John Morton Miller, Charles S. Morris and Everett W. Rust were assistants.

1909–10 William M. Davidson, M. M. Vogel, William M. Mann, Everett W. Rust were assistants.

1910–11 David T. Fullaway, W. M. Mann, E. J. Newcomer, C. E. Pemberton, F. M. Russell and W. F. Thompson were assistants.

Professor Kellogg was absent on leave the second semester of 1911–12. The assistants for this year were D. L. Crawford, E. J. Newcomer, Harold Morrison, and Frankie Willard.

McCracken was absent on leave during the year 1913–14 and Erval J. Newcomer was acting instructor and Gordon Floyd Ferris was undergraduate assistant.

In 1914–15 Fred Matlock Trimble was assistant and Ferris undergraduate assistant.

During the year 1915–16 Kellogg was absent on leave during the first semester and Laura Florence and Kern Babcock Brown and Gordon Ferris acted as assistants.

1916–17 Kellogg was absent on leave having accepted a position as secretary of the National Research Council.

1917–18 Ferris was made instructor.

1920–21 Kellogg resigns as professor of entomology at Stanford and the Department of Entomology was made a division of the Department of Zoölogy with Doane associate professor of entomology, McCracken assistant professor and Ferris acting professor.

1924–25 McCracken was made associate professor.

1925–26 Ferris was made assistant professor and Ralph H. Smith was named as acting assistant professor for the year.

1926–27 Doane was named professor of entomology.

1927–28 Ferris was made associate professor.

Comstock's time here was devoted chiefly to teaching the general principles of entomology and building up the collections, particularly in Coccidæ and Lepidoptera, and, in addition to his regular lectures, gave a number of popular lectures.

W. G. Johnson was interested particularly in economic entomology and devoted a good deal of time to the study of the Mediterranean flour moth which had recently made its appearance in California.

In addition to his work in general entomology Kellogg early began the study of Mallophaga and soon built up the most complete collection of these parasites to be found in the United States. He also wrote a great deal on the anatomy of certain insects and did some systematic work on the Blepharoceridæ, later publishing a fascicle on this family in the Genera Insectorum. Later he became much interested in the study of evolution and bionomics and for many years, together with David Starr Jordan, offered courses in bionomics. Kellogg has written many articles and published several books

on this subject. During the World War he was associated with Herbert Hoover in the Belgium relief work and, as noted above, in 1920 resigned to become secretary of the National Research Council.

During the time that W. A. Snow was here he was interested particularly in systematic work on Diptera.

R. E. Snodgrass was interested particularly in anatomical work and was especially proficient in illustrating the detail morphology of the insects with which he was working.

S. I. Kuwana did some work with the Mallophaga and a good deal of work with the scale insects while he was here at Stanford.

Ruby Green Bell was especially interested in bionomics.

M. I. McCracken became interested in entomology from an evolutionary standpoint and has always devoted a great deal of her time to this phase of the subject. Later she became more interested in morphology, the classification and general biology of insects and during recent years has devoted herself almost entirely to these subjects. Her work has been largely in Cynipidæ and Aphididæ.

R. W. Doane was for many years interested in the Diptera, and published many papers giving descriptions of new species particularly in the families Trypetidæ and Tipulidæ. Later he became interested in scale insects and other economic insects and for many years has devoted himself to economic entomology and the study of the relation of insects to diseases.

G. F. Ferris' interest has been almost wholly systematic. He has worked principally on Coccidæ, Mallophaga, and Anoplura.

Pomona College, a liberal arts college, was founded at Claremont, Los Angeles County, in 1890. A Department of Biology was established in 1893, when A. J. Cook, of the Michigan Agricultural College and one of the leading economic entomologists of the time, was made Professor of Biology. From the beginning he emphasized entomology and in order to promote the teaching of this science secured the services of C. F. Baker, a former student of his, in 1904 and in 1907–1912. Baker brought a large entomological collection taken in the western states and in Brazil, containing a considerable number of types and paratypes, which he presented to the college and which is still there. In addition to the teaching of entomology he and Cook instituted an insect pest survey of the citrus orchards in the vicinity of Claremont, San Dimas, Pomona and Upland. They also founded the Pomona College Journal of Entomology in 1909.

Cook became State Commissioner of Horticulture in 1911 and Baker took a position as Professor of Agronomy at the University of the Philippines at Los Banos, Philippine Islands, in 1912, being succeeded by W. A. Hilton as Professor of Zoölogy and D. L.

Crawford as Professor of Botany. In 1913 Hilton changed the title of the Journal of Entomology to the Journal of Entomology and Zoölogy, under which name it is now issued.

In 1909 Cook and Baker presented their personal libraries to Pomona College and it was incorporated in the regular library as the Cook-Baker Library.

In Pomona College entomology was first taught in the Department of Biology and then in the Department of Zoölogy since its creation in 1912.

The Society of Natural History, San Diego.[38] This organization had its beginnings at a small meeting held in the law offices of Daniel Cleveland, a botanist, in San Diego in 1874. O. N. Sanford, who came to San Diego in 1872 and who was specially interested in Coleoptera, became the first curator of entomology.

He was succeeded by Geo. H. Field, an old time entomological collector in southern California, first interested in Coleoptera and later in Lepidoptera. The present curator, W. S. Wright,[39] was appointed in 1923. Wright is a lepidopterist, being particularly interested in the Geometridæ. In 1924 he presented his splendid collection of 40,000 specimens of Lepidoptera to the San Diego Museum and has increased it to 100,000 specimens in 1928.

One of the buildings erected for the Panama-California Exposition, 1915–1916, is used as the Natural History Museum. In 1920 the Scripps family gave the museum a substantial endowment, which, with private subscriptions and memberships, carries on the work of the society and museum.

An important entomological paper, appearing in the Transactions of the San Diego Society of Natural History, is A Preliminary List of the Hemiptera of San Diego County, California, by E. P. Van Duzee, vol. 2, no. 1, pp. 1–57 (Nov., 1914). In it are enumerated 392 species or varieties, 52 of which, and four genera are new.

The California Entomological Society[40] was organized at the call of E. M. Ehrhorn, in the office of Alexander Craw, State Board of Horticulture, on March 13, 1891. The meeting was opened by Ehrhorn who was elected chairman and Alexander Craw was elected secretary pro tem. After the adoption of a constitution and by-laws the following officers were elected:

[38] Gunder, J. D., *Entom. News*, vol. 15, pp. 33–34, pl. II (1929).

[39] *Ibid.*, p. 34, portrait, pl. II (1929).

[40] *The California Fruit Grower*, vol. 8, pp. 177, 275 (1891); vol. 9, pp. 84, 331 (1891); vol. 11, p. 357 (1892).

President	E. M. Ehrhorn, Mountain View.
Vice-President	Wm. H. Robinson, Stockton.
Secretary	Alexander Craw, Quarantine Officer, State Board of Horticulture, San Francisco.
Treasurer	Emory E. Smith, Editor of the California Fruit Grower, San Francisco.
Directors	C. C. Reidy, microscopist, and B. N. Rowley, Publisher and Proprietor of the California Fruitgrower, San Francisco.

It was decided to levy an initiation fee of $2.50 and dues, $3.00. Meetings were to be held quarterly. Apparently but four regular meetings were held; April 24, July 31, Nov. 12, 1891, and Oct. 22, 1892.

The Pacific Coast Entomological Society.[41] On August 7th, 1901, Carl Fuchs issued the following call for the organization known as the California Entomological Club:

With the view of organizing a Club of Entomologists on the Pacific Coast, for the purpose of promoting interest in Entomological research, a meeting will be held at the California Academy of Sciences on Thursday, Aug. 15th, at 2 o'clock.

You are urgently invited to attend this meeting.

The following entomologists responded in person:

Carl Fuchs, Dr. E. C. Van Dyke, H. C. Fall, L. E. Ricksecker, Dr. H. H. Behr, W. G. W. Harford, Beverly Letcher, F. W. Nunenmacher, Dr. F. E. Blaisdell, Wm. Ashmead.

The following communicated by letter:

J. G. Grundel, C. A. Whiting, Newton B. Pierce, C. W. Herr, Dr. A. Fenyes, Geo. W. Harney, F. C. Clark, J. J. Rivers, Dr. L. O. Howard, Edw. M. Ehrhorn, James E. Cottle, Alex. Craw, Prof. Vernon Kellogg, and Grattum Naturalists Club.

Pursuant to call, the meeting convened on Aug. 15th, 1901, in the California Academy of Sciences, San Francisco.

H. C. Fall, acting as temporary President, opened the meeting with a few appropriate remarks.

The following officers were then elected to serve for the current year:

Carl Fuchs, President; Prof. Vernon L. Kellogg, Vice-President; Dr. F. E. Blaisdell, Secretary and Treasurer.

President Fuchs then took the chair and after a short address, proceeded to the further organization of the Society.

The name adopted for the new organization was the California Entomological Club.

A constitution and by-laws were formulated and accepted. The following is a list of the charter members:

[41] *Proceedings of the Pacific Coast Entom. Soc.*, vol. 1, no. 1 (1904), to vol. 2, no. 5 (1926). Includes minutes of one hundred and four meetings.

Carl Fuchs, Edwin C. Van Dyke, H. C. Fall, L. E. Ricksecker, H. H. Behr, W. G. W. Harford, Beverly Letcher, F. W. Nunenmacher, Wm. Ashmead, Edward M. Ehrhorn, James E. Cottle, F. E. Blaisdell, J. G. Grundel, C. A. Whiting, Newton B. Pierce, C. W. Herr, Geo. W. Harney, F. C. Clark, J. J. Rivers, L. O. Howard, L. Durstein, Grattum Naturalists Club.

The name was changed to the Pacific Coast Entomological Society at the fifth regular meeting on August 16, 1902. It was affiliated with the Pacific Branch of the American Association for the Advancement of Science on March 20, 1919. Proceedings have been published for one hundred and four meetings to May 1, 1926. This society founded and sponsored the publication of the Pan-Pacific Entomologist begun with volume 1, no. 1, July, 1924, with E. P. Van Duzee as editor, E. C. Van Dyke assistant editor, F. H. Blaisdell, treasurer, 1924–26, S. B. Freeborn, treasurer, 1926– ; E. O. Essig (Chairman), G. F. Ferris, E. C. Van Dyke, R. W. Doane, Grant Wallace, W. W. Henderson and J. C. Chamberlin, publication committee.

The officers have been as follows: President—Carl Fuchs, 1901–1906; E. C. Van Dyke, 1907–to date. Vice-President (not regularly elected)—V. L. Kellogg, 1901; H. C. Fall, 1902–1910; J. E. Cottle, 1911–1923; G. F. Ferris, 1924–to date. Secretary-Treasurer—F. E. Blaisdell, 1901–1925; J. O. Martin, 1926–to date. To date there are ninety-eight members.

The Pacific Slope Association of Economic Entomologists was organized at the close of the Pacific Coast Entomological Conference, called by C. W. Woodworth, at the University of California, April 20 to 23, 1909.[42] At this conference there were representatives from all of the Pacific Coast States, west of the Rocky Mountains and also from British Columbia. A splendid attendance resulted and the following program was carried out:

Tuesday afternoon (April 20), "Lime-sulfur, its use and manufacture"; Tuesday evening, "The manufacture of miscible oils and arsenical insecticides"; Wednesday morning (April 21), "The European elm scale and the codling moth"; afternoon, "The orange scale and the citrus mealy bug"; evening, exhibits of insecticide materials, insect collections, apparatus illustrating methods of study, etc.; Thursday morning (April 22), visit to Oakland formicary; afternoon, "Forest insects and apiculture"; evening "Medical entomology"; Friday morning (April 23), "Methods used in the study of sensory reactions, insect photography"; afternoon, permanent organization.

The meeting was well attended notwithstanding the enormous distances separating the workers on the Pacific Coast. As had been hoped at the outset, a permanent organization was effected under the name of Pacific Slope Association of Economic Entomologists. The constitution adopted required that active membership shall be limited to the official and professional entomologists of the Pacific Slope, while associate membership shall be open to agriculturists

[42] *Calif. Agr. Expt. Sta., Circ. 42*, pp. 1–6 (1909).
Herms, W. B., *Jour. Econ. Entom.*, vol. 2, p. 264 (1909).
Calif. Fruit Grower, vol. 39, p. 8 (May 1, 1909).

and to all others interested in the objects of this association. The following officers were elected, viz.: President, Professor C. W. Woodworth, University of California, Berkeley, Cal.; vice-presidents (representing each state concerned), Prof. R. W. Doane, Palo Alto, Cal.; Prof. S. B. Doten, Reno, Nevada; Prof. J. Elliott Coit, Phoenix, Arizona; Prof. Fabian Garcia, P. O. Agricultural College, New Mexico; Prof. E. D. Ball, Logan, Utah; Prof. A. B. Cordley, Corvallis, Oregon; Prof. A. L. Melander, Pullman, Washington; Prof. L. F. Henderson, Moscow, Idaho; Prof. C. P. Gillette, Fort Collins, Colorado; Prof. R. A. Cooley, Bozeman, Montana; Prof. Aven Nelson, Laramie, Wyoming; Hon. Thomas Cunningham, Vancouver, B. C. Executive Committee, Mr. R. R. Rogers, San Francisco, Cal.; Mr. H. P. Stabler, Yuba City, Cal., Mr. L. H. Day, Oakland, Cal.; secretary-treasurer, Prof. W. B. Herms, University of California, Berkeley, Cal.

It is planned to hold the next meeting this summer at Portland, Oregon, in conjunction with the American Association for the Advancement of Science.

The association flourished and by 1911 there were according to the records of R. C. Treherne, secretary and treasurer, eighty-five active members.

On August 9 and 10, 1915, a special meeting of the American Association of Economic Entomologists was held at the University of California, Berkeley, and joint sessions were held with the Pacific Slope Association. There was an average attendance of forty-five most of which were members of the latter. At this meeting a special committee,[43] was appointed with regard to an affiliation of the two associations. The report of this committee follows:

"REPORT OF SPECIAL COMMITTEE[44]

"Your committee, appointed to confer with a like committee from the Pacific Slope Association of Economic Entomologists with reference to an affiliation, recommend that that Association be affiliated as a branch association to be known as the Pacific Slope Branch of the American Association of Economic Entomologists and the membership requirements, dues and privileges of its members be the same as for other members of this Association.

"It is further recommended that the following amendment to the constitution providing for this change be adopted.

"That the words 'Branch or' be inserted before the word 'section' in line 2 of Section 1 of Article 3 of the Constitution.

"Respectfully submitted,
"C. P. Gillette,
"A. F. Burgess,
"E. D. Ball,
"E. O. Essig,
"Committee."

After a general discussion it was voted that the report be accepted and that the recommendations be presented to the American Association of Economic Entomologists at the next annual meeting.

[43] *Jour. Econ. Entom.*, vol. 8, pp. 441, 499 (1915).

[44] As the members of the committee agreed on the matters under consideration, a joint report was submitted.

At the twenty-eighth annual meeting of the American Association of Economic Entomology, the Pacific Slope Association of Economic Entomology was made a branch of the former Association and designated as the Pacific Slope Branch of the American Association of Economic Entomologists.[45]

Since that time this branch has yearly elected its officers consisting of a chairman (and later also a vice-chairman), a secretary-treasurer, and various committees. The Chairman has regularly been elected as the second vice-president of the parent association. Annual meetings are held regularly in affiliation with the Pacific Division of the American Association for the Advancement of Science. The proceedings are published in the Journal of Economic Entomology. The following table summarizes the activities of the Pacific Slope Branch since its organization in 1915.

Year	Chairman	Vice-Chairman	Secretary-Treasurer	Place of Meeting	Dates of Meeting
1915–16	E. D. Ball		E. O. Essig	San Diego, Calif.	Aug. 10–11, 1916
1916–17	A. W. Morrill	H. J. Quayle	"	Stanford Univ., Calif.	Apr. 5–6, 1917
1917–18	G. P. Weldon		"	Riverside, Calif. Alhambra, Calif.	Mar. 28, 1918 Mar. 29, 1918
1918–19	H. J. Quayle		"	Riverside, Calif.	May 28, 1919
1919–20	E. M. Ehrhorn	R. W. Doane	"	Univ. Washington, Seattle, Wash.	June 17–18, 1920
1920–21	E. O. Essig		A. L. Lovett	Univ. California, Berkeley, Calif.	Aug. 4–5, 1921
1921–22	A. L. Lovett		E. O. Essig	Univ. Utah, Salt Lake City, Utah	July 22, 1922
1922–23	H. J. Quayle		"	Univ. So. Calif., Los Angeles, Calif.	Sept. 17–19, 1923
1923–24	H. S. Smith	C. M. Packard	R. E. Campbell	Stanford Univ., Calif.	June 27–28, 1924

[45] *Jour. Econ. Entom.*, vol. 9, pp. 11–12 (1916).

Year	Chairman	Vice-Chairman	Secretary-Treasurer	Place of Meeting	Dates of Meeting
1924–25	Leroy Childs	S. B. Freeborn	R. E. Campbell	Reed College, Portland, Oregon	June 18–20, 1925
1925–26	W. B. Herms	E.J.Newcomer	"	Mills College, Oakland, Calif.	June 17–18, 1926
1926–27	R. W. Doane	R. S. Woglum	"	Univ. Nevada Reno, Nev.	June 22–23, 1927
1927–28	R. S. Woglum	G. M. List	"	Pomona College, Claremont, Calif.	June 14–15, 1928
1928–29	O. H. Swezey	S B. Freeborn	"	Univ. California, Berkeley, Calif.	June 20–21, 1929
1929–30	D. C. Mote	P. Simmons	"	Univ. Oregon, Eugene, Ore.	June 19–21, 1930

The Lorquin Natural History Club, named for the early naturalist, P. J. M. Lorquin, was organized at Los Angeles, California, in August, 1913. It published a small journal of natural history known as Lorquinia, which was begun in 1916 and ended with the second volume in January, 1919. Paul Ruthling was the editor. The club had a large membership including some of the leading biologists of southern California. It ceased to exist in 1924.

The Lorquin Entomological Club [46] was first organized as the entomological section of the Lorquin Natural History Club in Los Angeles, California, September 7, 1917 by Fordyce Grinnell. The first meeting was held in the Los Angeles Public Library. Although the parent organization went out of existence at this time the old name was retained. During 1918 and part of 1919 the meetings were held in the San Fernando Building, Los Angeles, and in March of the latter year, under the leadership of J. A. Comstock, Hal Newcomb, Geo. Malcolm and J. D. Gunder, meetings were held at the Southwest Museum, Los Angeles. When the Southwest Museum was reorganized so as to include only anthropology, the activities of the entomological section were transferred to the Los Angeles Museum. At the first meeting of the section at this place in 1927 the name was changed to The Lorquin Entomo-

[46] Gunder, J. D., *Entom. News*, vol. 40, pp. 68–69 (1929).

logical Society. The membership is wholly active and numbers 51 members (June, 1929). The presidents in order of office have been: Fordyce Grinnell, J. A. Comstock, Hal Newcomb, Geo. Malcolm, J. D. Gunder, F. M. Friday.

Every year in the spring the society sponsors a Butterfly or Insect Show which is held in the museum. This show occupies a large room and is a very creditable exhibition which has justly received great praises and wide comment. It is the only exhibit of this kind held in America. The 8th Annual Exhibit held in 1929 was specially fine.[47]

This society is directly affiliated with the American Association for the Advancement of Sciences.

The Entomological Club of Southern California. [48] As an outgrowth of a seminar for entomological students held at the University of California Citrus Experiment Station, Riverside, during 1925–1926, a committee consisting of H. J. Quayle, H. J. Ryan, R. S. Woglum, and R. E. Campbell, drew up a constitution and organized the Entomological Club of Southern California on November 17, 1926. At the first meeting held at the office of the Bureau of Entomology at Alhambra, forty entomologists, and county horticultural commissioners and inspectors were present.

Since then all day meetings (10 A.M. to 4 P.M.), have been held quarterly on the second Friday in March, June, September, and December, at the City Hall, Alhambra, or at the Los Angeles Museum. The average attendance to date has been over fifty.

From an original charter membership of twenty-eight the number has increased to over one hundred in 1928.

The officers have been as follows:

Date	President	Vice-President	Secretary-Treasurer
1926–1927	H. J. Quayle	R. S. Woglum	R. E. Campbell
1927–1928	H. J. Ryan	G. P. Weldon	C. K. Fisher
1928–1929	R. E. Campbell	P. R. Jones	C. J. Elmore

The California Entomological Club. The second organization bearing this name was organized at the Elks' Club, Sacramento,

[47] The *Los Angeles Times* under date of March 17, 1929, gave a full page with free illustrations to this show. Some 300 articles, about the insects exhibited were written by the Los Angeles school children for prizes. The exhibit is equal in popularity to a flower show.

[48] The information concerning this club was furnished by R. E. Campbell.

California, May 25, 1930. About 85 delegates were present and after a short program a permanent club was organized with the following officers: President, S. Lockwood, who more than anyone else was responsible for calling the meeting; Vice-president, E. O. Essig; Secretary-treasurer. H. E. Burke.

CHAPTER V

SOME HISTORICAL FACTS CONCERNING THE MORE IMPORTANT ORCHARD MITES AND INSECTS OF CALIFORNIA

It would be highly desirable to give here a complete account of all the known economic and otherwise interesting insects in California, but time and space will not permit of such a full discussion in this chapter. Therefore only a few of the more important ones are treated together with a few, concerning which facts were not generally known. In the chronological table in the last chapter will be found dates and miscellaneous facts concerning a great many others not discussed here. The reader is also referred to the index for references to insects discussed elsewhere in this book, particularly in connection with the Indians and early development of entomology in California.

ACARINA (Group)

Mites

ORCHARD MITES

The various orchard and plant mites were probably introduced into California along with the first imported nursery stock from the Eastern states and from Europe.

The common red spider, *Tetranychus telarius* (Linn.) or *T. pacificus* McGregor,[1] was noted on grapes at Fresno by Gustav Eisen in 1876.

[1] McGregor, E. A., *Proc. U. S. Nat. Mus.*, vol. 56, pp. 657–658, pls. 77, 79, fig. 12 (1920). Original description.

Parker, W. B., *The red spider on hops in the Sacramento Valley of California*, U. S. Dept. Agr., Bur. Entom., Bul. 117, 41 pp., 9 figs., 6 pls. (1913). *Tetranychus bimaculatus* Harvey.

Ewing, H. E., *The common red spider or spider mite*, Ore. Agr. Expt. Sta., Bul. 121, 95 pp., 30 figs., 2 pls. (1914).

De Ong, E. R., Calif. Agr. Expt. Sta., *Bul. 347*, pp. 41–45, fig. 1 (1922). Listed as *Tetranychus telarius* (Linn.).

Essig, E. O., *Insects Western No. Am.*, pp. 27–29 (1926). Listed as *Tetranychus telarius* (Linn.).

In 1881 Matthew Cooke [2] states: "The red mite, commonly called red spider, may be said to be a universal pest of the garden and hothouse, and, within a few years, has spread (as it were, unnoticed), until many orchards in this state are seriously infested by it. This pest is especially noticeable on almond trees, and is found on the apple, pear, plum, cherry, etc. . . . Dr. S. F. Chapin, of San José, exterminated the mites and ova on young deciduous trees by washing with a solution: One pound of concentrated lye to one gallon of water."

In 1882 W. B. West [3] made a statement which would indicate that **the Pacific mite,** *T. pacificus* McG., was the one responsible for the greatest damage to fruit trees then just as it is now. He said: "Among the most serious insects pests with which the warm and dry portions of our state are affected, is the red spider, or mite. It is probably indigenous, as it is found upon the oaks and willows, and even upon the grass, weeds, and shrubs, along our streams. This insect attacks the leaves of the almond, plum, walnut, chestnut, and gooseberry, and does great damage by checking their growth. Upon the apple and pear its work is not so destructive, and the apricot suffers but little. The damage to nursery trees is considerable. On very dry years, it attacks the fruit tree stocks rendering budding difficult, also checking the growth of yearling trees. In my experiments upon nursery trees, I have used water syringed upon them, afterwards dusting with sulfur." In 1881 prune trees were severely infested at Stockton.

Sulfur applied as a dust and as a liquid spray continued to be the most important remedy for the red spiders [4] until the highly refined oil sprays began to appear in 1922. These oil sprays have not even yet entirely replaced the sulfur dusts and sulfur compounds.

The almond mite, *Bryobia prætiosa* Koch, was no doubt present in California many years before it was detected as a distinct species. Eggs collected on almond at San Diego, California, in 1879 were sent by E. J. Wickson to H. Garman who determined them as this mite.

The citrus red spider, *Paratetranychus citri* (McGregor), was long supposed to have been the species named *Penthalodes mytil-*

[2] *A treatise on the insects injurious to fruit and fruit trees of the State of California,* pp. 21–22 (1881).

[3] Calif. Bd. State Hort. Com., *1st Rept.*, pp. 20–21 (1882).

[4] For other species of red spiders occurring in California see Essig, E. O., *Insects of Western North America,* pp. 24–33 (1926).

FIG. 44.—A portion of a group of eggs of *Bryobia* sp., on aspen. These overwintering eggs were collected at Echo Lake, California, at an altitude of 7,500 feet on October 18, 1927. The picture gives some idea of the prolificness of these tiny mites.

aspidis by C. V. Riley [5] in 1885 and subsequently placed in the genus *Tetranychus* by N. Banks in 1900.[6] In California it has gone under the name, *Tetranychus mytilaspidis* (Riley) until the taxonomic status of the mite was worked out by McGregor[7] in 1916 and a new specific name *citri* given to it by him. In 1919 he referred it to the genus *Paratetranychus*.[8]

It is supposed to have been introduced into California on citrus nursery stock from Florida about 1890 and rapidly spread over the citrus area south of the Tehachapi. In 1912 Quayle [9] gave a complete account of this and other mites attacking citrus trees in California. Many articles concerning the mite and its control in this state have appeared in the agricultural press and scientific papers.[10]

While some investigators believe this mite to be identical with the European red mite, *Paratetranychus pilosus* C. & F., its specific rank is still defended by McGregor and Newcomer.[11]

The European red mite, *Paratetranychus pilosus* (C. & F.),[12] was early introduced into North America from Europe on nursery stock. In northern California it has been known to occur on decid-

[5] Hubbard, H. G., *Insects affecting the orange*, U. S. Dept. Agr., Div. Entom., p. 216 (1885).

[6] *The red spiders of the United States*, U. S. Dept. Agr., Div. Entom. Tech. ser. 8, p. 71 (1900).

[7] McGregor, E. A., *The citrus mite named and described for the first time.*, Ann. Entom. Soc. Am., vol. 9, pp. 284–288, pls. xiii–xiv (1916).

[8] McGregor, E. A., *Proc. U. S. Nat. Mus.*, vol. 56, p. 672 (1919).

[9] Quayle, H. J., *Red spiders and mites of citrus trees*, Calif. Agr. Expt. Sta., Bul. 234, pp. 487–492, fig. 4 (1912).

[10] Woodworth, C. W., *The red spider of citrus trees*, Calif, Agr. Expt. Sta., Bul. 145, 19 pp., 6 figs. (1902).

Essig, E. O., *Injurious and beneficial insects of California* Calif. State Hort. Com. Mthly. Bul., vol. 2, pp. 9–10, fig. 11 (1913); ed. 2, pp. 14–17, fig. 16 (1915).

[11] McGregor, E. A., and Newcomer, E. J., *Taxonomic status of the deciduous-fruit* Paratetranychus *with reference to the citrus mite* (P. citri), Jour. Agr. Research, vol. 36, pp. 157–181, 6 figs. (1928).

[12] Canestrini, G., and Fanzago, F., *Intorno agli acari Italiani*, Atti R. Ist. Veneto Sci., Let. ed. Art. (5) vol. 4, pp. 69–208, figs. (1877–1878). *Tetranychus pilosus*. Original description.

Ewing, H. E., *The occurrence of the citrus red spider,* Tetranychus mytilaspidis *Riley, on stone and pomaceous fruit trees in Oregon*, Jour. Econ. Entom., vol. 5, pp. 414–415 (1912).

Cæsar, L., *An imported red spider attacking fruit trees.* Can. Entom., vol. 47, pp. 57–58, figs. 5–6 (1915). *Tetranychus pilosus.*

Frost, S. W., *Jour. Econ. Entom.*, vol. 12, pp. 407–408 (1919).

Garman, P., *The European red mite* (Paratetranychus pilosus *Can. & Fanz.*) *in Connecticut*, Jour. Econ. Entom., vol. 14, pp. 355–358, fig. 7 (1921).

The European red mite, Conn. Agr. Exp. Sta., Bul. 226, pp. 184–189, figs. (1921); Bul. 252, pp. 103–124, pls. v–viii (1923).

Essig, E. O., *The European red mite in California*, Jour. Econ. Entom., vol. 15, pp. 181, 246 (1922).

uous fruit trees at least as early as 1913.[13] In view of the fact that the mite was confused with the citrus red spider, earlier records are difficult to interpret.

In September, 1912, L. Cæsar took specimens of this mite on fruit trees at Ontario, Canada, and sent them to Nathan Banks who determined the species as *Tetranychus pilosus* C. & F. This is the first authentic record of the mite in this country. Immediately following, the mite was reported in various states as follows:

Ontario, Canada, 1912, L. Cæsar.
Oregon, 1912, H. E. Ewing (*Tetranychus mytilaspidis*).
California, 1912, E. O. Essig (" ").
New York, 1915, P. J. Parrott (" ").
Maryland, 1915, C. C. Hamilton.
Washington, 1916, E. J. Newcomer.
Pennsylvania, 1919, S. W. Frost.
Connecticut, 1920, P. Garman.
Ohio, 1920, C. G. Williams.

Since 1920 it has been found widely distributed throughout the northern part of the United States and in Canada.

The work of **the pear-leaf blister-mite,** *Eriophyes pyri* (Pagen.), was observed on pear leaves in Shasta County, California, in March, 1894,[14] although the mite was probably introduced into the state on pear seedlings and grafts much earlier. By 1903 it was well distributed throughout the state. Early spraying with kerosene emulsion and dusting with flowers of sulfur were the recommended methods of control.[15] In 1913 it was first reported as injuring fruit in Nevada and Eldorado counties [16] and the next year this type of injury was reported in the counties of Contra Costa, Fresno, Modoc, San Joaquin, and Sonoma.[17] In the winter of 1922 the mites

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The European red mite, Calif. State Dept. Agr., Mthly. Bul., vol. 11, pp. 409–411, fig. 154 (1922).

Insects of Western No. America, pp. 29–30 (1926).

McGregor, E. A., and Newcomer, E. J., *Taxonomic status of the deciduous-fruit* Paratetranychus *with reference to the citrus mite* (P. citri), Jour. Agr. Research, vol. 36, pp. 157–186, 6 figs. (1928). Bibliography.

Newcomer, E. A., and Yothers, M. A., *Experiments for the control of the European red mite and other fruit-tree mites*, U. S. Dept. Agr., Tech. Bul. 25, 33 pp., 5 figs. (1927).

Biology of the European red mite, ibid., Tech. Bul. 89, 69 pp., 25 figs. (1929). Complete bibliography.

[13] Essig, E. O., *Injurious and beneficial insects of California*, p. 9 (1913).

[14] Craw, A., Calif. State Bd. Hort., *Rept.*, 1893–1894, p. 439 (1894).

[15] Ehrhorn, E. M., Calif. State Bd. Hort., *Rept.*, 1903–1904, p. 122 (1904).

[16] Essig, E. O., Calif. Hort. Com., *Mthly. Bul.*, vol. 2, pp. 563–564, fig. 333 (1913).

[17] Weldon, G. P., *ibid.*, vol. 3, p. 338 (1914).

were observed to seriously injure the dormant blossom buds on the pear trees and since that time this type of work has been observed in all of the infested areas and particularly in the hotter and dryer areas. At the present time this mite is common and injurious in the pear orchards throughout the state being most troublesome in the hotter and drier valleys and almost entirely absent along the coast. It is controlled by applying dormant lime-sulfur sprays preferably in November. Spring applications are still made by some growers but only the fall sprays will insure against injury to the overwintering buds.

The rust or silver mite, *Phyllocoptes oleivorus* (Ashmead), was introduced into California from Florida in 1889 [18] and has made very little headway in the southern citrus areas. With the exception of one small infestation noted on lemon at Santa Barbara by G. A. Coleman in 1913, the mite has been confined to a small area in the Chula Vista district of San Diego County, where it has only occasionally appeared in sufficient numbers to attract attention.

The pear-leaf rust mite, *Epitrimerus piri* (Nalepa), was first noted on pear trees in San Diego County by G. P. Weldon[19] in 1913. The next year its work was observed in Contra Costa, Sonoma Modoc, Yolo, San Joaquin, and Fresno counties.[20] At the present time the mite is of little importance and appears to be most evident in the Sacramento and San Joaquin valleys.

The peach silver mite, *Phyllocoptes cornutus* Banks, was first noted by F. Seulberger on peach in Alameda County and by G. P. Weldon on peach in Fresno County in 1914.[21] At that time the mite was believed to be the pear-leaf rust mite.

In 1922 the mite was noted in considerable numbers silvering the leaves of peach at Ontario, Davis and in Sutter County and on prune in the Santa Clara Valley. Since then what is believed to be this mite has been reported from many parts of the state.

The blackberry mite, *Eriophyes essigi* Hassan, was first noted as causing the so-called redberry disease of the Himalaya blackberry in Santa Clara and Santa Cruz counties by E. H. Smith and

[18] Quayle, H. J., *Red spiders and mites of citrus trees*, Calif. Agr. Expt. Sta., Bul. 234, p. 494 (1912).

[19] Calif. State Hort. Com., *Mthly. Bul.*, vol. 2, p. 668 (1913).

[20] Weldon, G. P., *ibid.*, vol. 3, p. 338 (1914).

[21] *Ibid.*

the writer in the fall of 1921.[22] It was first determined as the European species, *E. gracilis* (Nalepa), and a general account of the mite together with the nature of the work and the control of the mite was published in 1925.[23] At that time it was known to occur only in Santa Cruz and Santa Clara counties. In 1928 it was known also in the counties of Alameda, Contra Costa, Ventura, and Los Angeles counties and in addition to the Himalaya blackberry was observed to attack the mammoth blackberry, loganberry and raspberry. It was controlled by the application of lime-sulfur, 4–8% at the time the new growth starts in the spring of the year. In 1927 A. S. Hassan found the mite and the nature of its work to be sufficiently different from the European species to warrant a new species and he named it *Eriophyes essigi*.[24]

The fig mite, *Eriophyes fici* Ewing, was discovered in some figs from Fresno County and various other places in the San Joaquin Valley by E. H. Smith in 1922.[25] The mite inhabits the interior of the Kadota, Smyrna, and White Adriatic figs and hibernates in the buds on the fig trees. It was no doubt introduced either from Europe or Asia Minor. In 1923 it was also found on some fig trees in San Mateo County. Its economic status is still uncertain.

DERMAPTERA (Order)

Earwigs

The European earwig, *Forficula auricularia* Linnæus,[26] (Fig. 45) was described from Europe in 1758 by the Swedish scientist

[22] Essig, E. O., and Smith, E. H., *Two interesting new blister mites, ibid.*, vol. 11, p. 63 (1922).

Essig, E. O., *ibid.*, p. 466 (1922).

[23] Essig, E. O., *The blackberry mite, the cause of the blackberry disease of the Himalaya blackberry and its control*, Calif. Agr. Expt. Sta., Bul. 399, 10 pp., 6 figs., 1 col. pl. (1925).

[24] Hassan, A. S., *The biology of the Eriophyidæ, with special reference to* Eriophyes tristriatus (*Nalepa*), U. C. Pub. Entom., vol. 4, p. 380, fig. L (1928).

[25] Essig, E. O., and Smith, E. H., Calif. State Hort. Com. *Mthly. Bul.*, vol. 11, p. 63 (1922).

Essig, E. O., *ibid.*, p. 466 (1922); *Insects of Western North America*, p. 47 (1926).

[26] Glaser, R. W., Forficula auricularia *in Rhode Island*, Psyche, vol. 21, pp. 157–158 (1914).

Jones, D. W., *The European earwig and its control*, U. S. Dept. Agr., Bul. 566, 12 pp., 8 figs. (1917).

Chapman, T. A., *Notes on early stages and life history of the earwig* (Forficula auricularia), Entom. Record and Jour. Variation, vol. 29, pp. 25–20, 3 pls. (1917).

Brindley, H. H., *Notes on certain parasites, food and capture by birds of the common earwig* (Forficula auricularia), Proc. Cambridge Phil. Soc., vol. 19, pp. 167–177 (1918).

Linnæus.[27] It is strictly an old world insect inhabiting Europe and portions of Asia and Africa and since introduced into other parts of the world. In Europe the following records are noted:

Russia (flowers), England (many kinds of plants including vegetables, flowers, hops, plums), Norway (vegetables), Denmark (vegetables, field beets), Austria, Poland, Germany (fruits), France (ornamentals), Italy, Switzerland (pear leaves) and the Azores.

In the New World it has been observed in South America, North America (household, flowers, vegetables, fruits), Australia, Tasmania (flowers, vegetables), and New Zealand (fruits).

Staub, W., *The earwig* (Forficula auricularia) *as a pest on pear tree leaves in Switzerland*, Schweiz. Obst.-u. Gartenbau-ztg., Monsingen, no. 20, pp. 313–314, 2 figs. (Oct. 15, 1919). Abstracts in *Mthly. Bul. Agr. Intell. Plant Dis.*, Rome, vol. 11, p. 148 (Jan., 1920). *Rev. Appld. Entom.*, Ser. A, vol. 9, p. 135 (1921).

Lovett, A. L., U. S. Dept. Agr., Bur. Entom., *Insect Pest Surv. Bul.*, 1, p. 78 (1921).

Treherne, R. C., *The European earwig in British Columbia*, Proc. Entom. Soc. Br. Columbia, Econ. ser. nos. 17–19, pp. 161–163 (October, 1923).

Frank, A., *The European earwig*, Bi-Mthly. Bul., Western Wash. Expt. Sta., vol. 11, pp. 55–56, 1 fig. (Sept., 1923).

Essig, E. O., *The European earwig in California*, U. S. Dept. Agr., Bur. Entom., Insect Pest Surv. Bul., vol. 3, p. 307 (1923); *Jour. Econ. Entom.*, vol. 16, pp. 458–459 (1923); *Pan-Pacific Entom.*, vol. 2, p. 45 (1925); *Insects of Western No. Am.*, pp. 63–65, figs. 36–37 (1926).

Fulton, B. B., *The European earwig in Oregon*, 17th Bien. Rept., Ore. State Bd. Hort. 1923, pp. 199–205, 2 figs. (1923).

Fulton, B. B., *Some experiments on poison baits for the European earwig*, Jour. Econ. Entom., vol. 16, pp. 369–376 (1923).

The European earwig, Oregon Agr. Expt. Sta., Bul. 207, 29 pp., 6 figs. (1924).

Some habits of earwigs, Ann. Entom. Soc. Am., vol. 17, pp. 357–367, 1 fig. (1924).

Gibson, A., *The European earwig: an undesirable pest*, Canada Dept. Agr., Circ. 24, 4 pp., 1 fig. (May, 1924).

Goe, M. T., *Eight months' study of earwigs (Dermaptera)*, Entom. News, vol. 36, pp. 234–238 (October, 1925).

Pussard, R., *A propos du régime alunentaire du perce-oreille* Forficula auricularia *L. (Dermaptera)*, Bul. Soc. Sci. Nat., Rouen, 1925, pp. 7–13 (October, 1925). (Predaceous habits.)

Atwell, H. C., and Stearns, H. C., *Report of work done, seasons 1925 and 1926, at the Portland insectaries with parasites of the European earwig*, Digonochæta setipennis, *Fallèn and* Rhacodineura antiqua *Meig.* Typewritten, 23 pp., Portland, Oregon (Nov. 1, 1926).

Atwell, H. C., *The European earwig* (Forficula auricularia *Linn.*), 19th Bien. Rept. Oregon Bd. Hort., pp. 86–103, 5 figs. (1927).

Davies, W. M., *Methods for collecting parasites of earwigs*, Bul. Entom. Research, vol. 17, pp. 347–350, 1 pl., 1 fig. (June, 1927).

Muggeridge, J., *The European earwig: its habits and control.* Some recent experimental work in New Zealand, New Zealand Jour. Agr., vol. 34, pp. 395–401, 4 figs. (June, 1927).

Wilson, G., and Lewis, H. C., *The European earwig and its control*, Calif. State Dept. Agr., Mthly. Bul., vol. 16, pp. 468–471 (August, 1927).

Thompson, W. R., *A contribution to the study of the dipterous parasites of the European earwig* (Forficula auricularia *L.*), Parasitology, vol. 20, pp. 123–158, 6 pls., 4 figs. (July, 1928).

[27] Linnæus, C., *Syst. Naturæ*, ed. 10, p. 423, no. 1 (1758).

In America the establishment of this insect in the various known localities to date (1929) is as follows:

1853 Exotic record. America (South America?). First American record. Lotos, vol. 3, p. 254 (1853).[28]
1909 Portland, Oregon.[29]
1911 Newport, Rhode Island.[30]
1915 Seattle, Washington.[31]
1916 Vancouver and New Westminster, British Columbia.[32]
1917 East Aurora, New York.[33]
1923 Berkeley, California.

In all of these areas the European earwig has gradually extended its distribution. In some of them it has become a household pest of major proportions and has also seriously injured flowers, ornamental shrubs, vegetables, forage crops, and fruits. Its future development along lines of economic entomology are still uncertain, but satisfactory control has been obtained by poison baits.

The introduction of natural enemies of the earwig from Europe into this country has been under way since 1925, but as yet no definite results are reported.

In California this pest was first observed in Berkeley in September, 1923,[34] when it was found invading residences in the manufacturing western border of the city near the San Francisco Bay. In 1925 it was first noted injuring plants in this state.[35] Several surveys [36] of the areas suspected of being infested have been made and the insect was found so scattered that an eradication campaign by the state was not attempted. Three conferences have also been held by entomologists of the University of California, the Horticultural Commissioner of Alameda County, and the entomologists of the State Department of Agriculture with the officials of the City of Berkeley without being able to interest the local authorities in methods of extermination or a definite plan of control. These failures may be attributed to the fact that as yet the insect has not greatly increased and is nowhere a real serious pest indoors or out.

[28] Hebard, Morgan, *Entom. News*, vol. 28, p. 323 (1917).
[29] Fulton, B. B., Ore. Agr. Expt. Sta., *Bul. 207*, p. 6 (1924).
[30] Jones, D. W., *op. cit.*, p. 1 (1917).
[31] Jones, D. W., *op. cit.*, p. 2 (1917).
[32] Treherne, R. C., *op. cit.*, p. 161 (1923).
[33] Felt, E. P., *N. Y. State Mus. Bul.*, 33d Rept., *N. Y. State Entom.*, 1917, pp. 11–12 (1918).
[34] Essig, E. O., U. S. Dept. Agr., Bur. Entom., *Insect Pest Surv. Bul.*, vol. 3, p. 307 (1903); *Jour. Econ. Entom.*, vol. 2, p. 45 (1923).
[35] Essig, E. O., *Pan-Pac. Entom.*, vol. 2, p. 45 (1925).
[36] Wilson, G., and Lewis, H. C., *op. cit.*

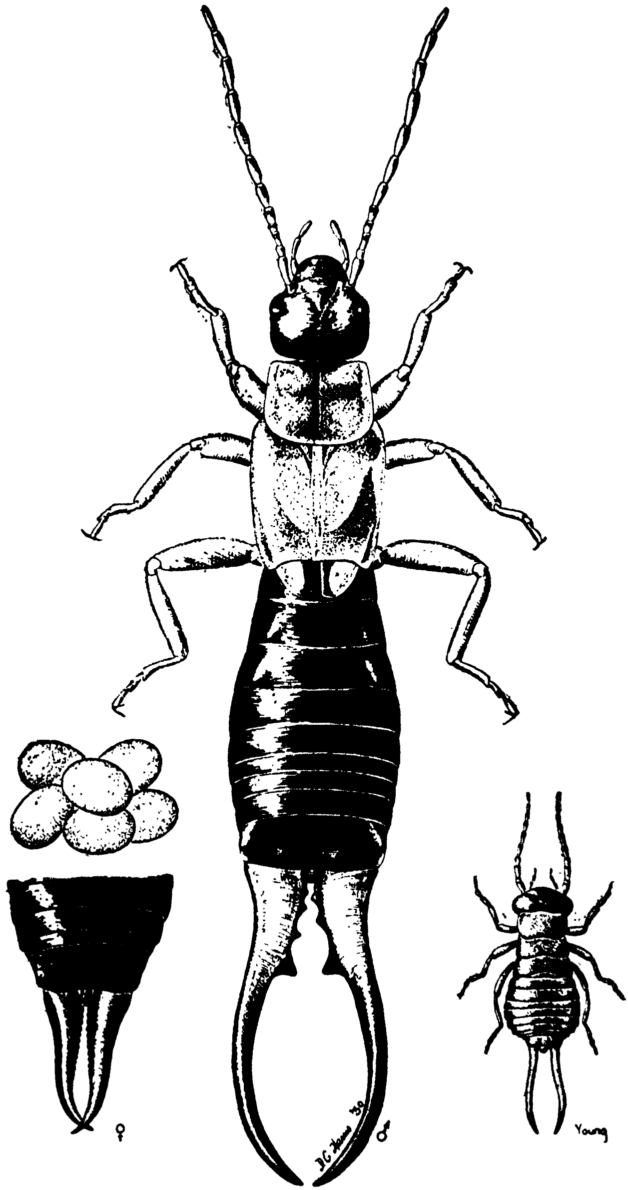

FIG. 45.—The European earwig, *Forficula auricularia* Linn., was first noted in the United States in Portland, Oregon in 1909. It later appeared in Newport, Rhode Island in 1911 and in Berkeley, California in 1923. In some localities its capacity for doing damage is considerable. The illustration shows the adult male, the anal pincers of the female, the eggs, and a single young. × 7½.

So far it has not displayed the same destructive potentialities shown further north.

At this writing the insect has been definitely found in California in the cities of Berkeley, Albany, Richmond, Oakland, and San Francisco, and has been reported on good authority from Santa Clara.[37]

On June 27, 1930, I received many living specimens from Pinole, where they were to be found in large numbers.

ORTHOPTERA (Order)

Grasshoppers, Katydids, Crickets, etc.

LOCUSTIDÆ (Family). Grasshoppers or Locusts.

Grasshoppers or locusts were the first destructive insects noted in California. Their presence in such great numbers and the immediate effects of their serious depredations were so conspicuous and serious as to receive immediate attention. In Lower California grasshoppers were noted at the missions as early as 1722, "when they made their appearance and then ceased until 1746, and for three years immediately following without intermission. After this they did not return until 1753 and 1754, and, finally again, before the expulsion of the fathers in 1765, 1766, and 1767." [38]

Since the founding of the first Mission in California in 1769, grasshopper invasions have been recorded as occurring in the state as follows: 1823, 1827 or 1828, 1834 or 1835, 1838, 1839, 1840, 1846, 1852, 1854, 1855, 1856, 1859, 1862 or 1863, 1866 or 1867, 1869, 1870, 1871, 1873, [39] 1875, 1877, 1878, 1879, 1880, 1882, 1883, 1884, 1885, 1886, 1887, 1888, 1890, 1891,[40] 1892,[41] 1896, 1897, 1898, 1902,[42] 1903, 1904.[43] These later invasions were not general over the state, but were local. However, they often covered considerable areas. Since 1904 there have been small invasions in 1910, 1912, and 1914, but none of any serious consequence since that time.

[37] E. W. Howe reported to me that he collected one specimen there in 1928 and ten in 1929.

[38] Clavigero, F. X., *History of California, 1852.* Quoted by Alexander S. Taylor in Smiths. Inst., *Ann. Rept.*, 1858, p. 209 (1859).

[39] U. S. Entom. Comm., *First Rept., 1877*, p. 456 (1878).

Taylor, A. S., *California Farmer*, p. 18 (January, 1858); p. 34 (February, 1858).

[40] Coquillett, D. W., *Report on the locust invasion of California in 1891*, U. S. Dept. Agr., Div. Entom., Bul. 27, pp. 34–57 (1892).

[41] Coquillett, D. W., *Dipterous parasites of* Melanoplus devastator *in California*, Insect Life, vol. 5, pp. 22–24 (1892).

[42] Woodworth, C. W., Calif. Agr. Exp. Sta., *Bul. 142*, pp. 19–20 (1902).

[43] Hunter, J. S., Calif. Agr. Expt. Sta., *Bul. 170* (1905).

Some idea of the extent of these grasshopper invasions may be gained from the interesting early accounts of Taylor,[44] extracts from which are given as follows:

Since 1823 the grasshoppers have several times ravaged the fields and gardens of the Franciscan Missions of upper California. About the year 1827 or 1828 they ate up nearly all the growing crops, and occasioned a great scarcity of wholesome food. At the Mission of Santa Clara, Padre José Viadere fired the pastures, and getting all his neophytes together made such an awful noise

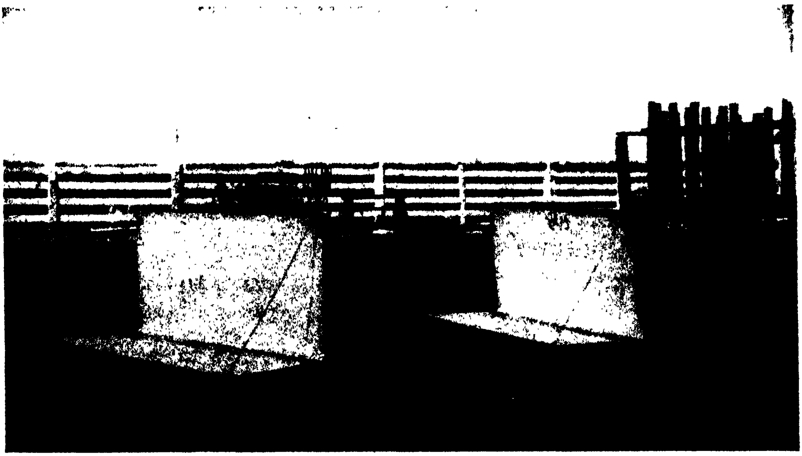

FIG. 46.—Small hopperdozers used for catching grasshoppers in California in 1901 and 1902. (After C. W. Woodworth, 1902.)

that those which were not killed by the smoke and fires were frightened off so thoroughly as to save the grain crops and the mission fruit gardens. About 1834–35 occurred another visitation of the grasshopper, when they destroyed a second time the crops of the rancheros and missions with the exception of the wheat (pp. 203–204).

From the periodical press we learn, that, up to the 11th of October, 1855, and commencing about the middle of May, these insects extended themselves over a space of the earth's surface much greater than has ever before been noted. They covered the entire territories of Washington and Oregon, and every valley of the State of California, ranging from the Pacific ocean to the eastern base of the Sierra Nevada; the entire territories of Utah and New Mexico; the immense grassy prairies lying on the eastern slopes of the Rocky Mountains; the dry mountain valleys of the republic of Mexico, and the countries of Lower California and Central America, etc. (pp. 200–201).

Col. Warren, editor of California Farmer, dated July 2, 1855, concerning locusts stated: "for the last three days, the very air has been so full of them

[44] Taylor, A. S., *An account of the grasshoppers and locusts of America*, condensed from an article written and furnished by Alexander S. Taylor, Esq., of Monterey, California, Smiths. Inst., Ann. Rept., 1858, pp. 200–213 (1859).

over this city (Sacramento) as to resemble a dense snow storm. Large fields of oats and wheat have suffered in Ione and other upper (Sierra Nevada) valleys" (p. 201).

The Sacramento Union, July 2, 1855 stated: the "Most remarkable circumstance we have ever been called on to notice in this locality was the flight of the grasshoppers on Saturday and yesterday. For about three hours in the middle of the day the air, at an elevation of about two hundred feet, was literally thick with them, flying in the direction of Yolo. They could be the more readily perceived by looking in the direction of the sun. Great numbers fell upon the streets on Saturday—absolutely taking the city by storm—and yesterday they commenced the wholesale destruction of everything green in the gardens of the neighborhood. Their flight, *en masse*, resembled a thick snowstorm, and their depredations the sweep of a scythe. The prevalence of the scourge is explained by Dr. T. M. Logan as being attributable to the great warmth and dryness of the present season—circumstances favorable to an early development of the eggs of the insect, which is deemed one of the most fruitful in the animal kingdom" (p. 201).

Nothing was known concerning the species of the early invasions. One of the species involved was later considered to be the Rocky Mountain Locust. A. S. Packard visited California in August, and again in October, 1877, to investigate the grasshopper conditions and reported that most of the injury was occasioned by **the red-legged locust,** *Melanoplus femur-rubrum* (De Geer) (*Caloptenus*) and **the lesser migratory locust,** *M. atlanis* (Riley) (*Caloptenus*).[45] In 1878 the common **devastating grasshopper,** *M. devastator* Scudder, was determined as a distinct species.[46]

In connection with grasshopper control, California made a great contribution in the poison bait, which was first used by farmers near Sacramento in 1885 and consisted of a mixture of arsenic, sugar, middlings, and water. D. W. Coquillett[47] at once recognized the importance of this discovery and immediately set to work to improve the formula and make known its value. His chief contribution was the substitution of bran for middlings. Since that time this poison bran mash has, with few modifications, been accepted the world over as the most effective means of controlling the grasshoppers. The grasshoppers which were most destructive in the San Joaquin Valley in 1885, the year of the discovery of the poison bran mash, are recorded by D. W. Coquillett in a list in

[45] U. S. Entom. Comm., *First Rept. 1877*, p. 21 (1888).
[46] Scudder, S. H., Bost. Soc. Nat. Hist., *Proc.*, vol. 19, pp. 285–286, 287–288 (1878).
[47] Rept. of Entom., U. S. Commr. of Agr., *Ann. Rept. 1885*, pp. 289–303 (1886).

which "the first species is represented by the number 1 and the second species by the number 4," indicating that there were four specimens of the latter species to every one of the former, and so on throughout the list.[48]

Psoloessa texana Scudder	1
Hesperotettix viridis Thomas	4
Conozoa wallula Scudder	6
Camnula pellucida Scudder	8
Acridium shoshone Thomas	10
Dissosteira venusta Stål	10
Trimerotropis vinculata Scudder	20
Trimerotropis sp.?	40
Trimerotropis sp.?	50
Melanoplus probable var. of *devastator*	50
Paroxya near *atlantica*	50
Trimerotropis sp.?	75
Dissosteira spurcata Saussure	100
Caloptenus differentialis Thomas	750
Melanoplus cinereus Scudder	1,000
Trimerotropis pseudofasciata Scudder	1,000
Melanoplus devastator Scudder	20,000

In addition to the above named species, **the valley grasshopper,** *Œdaleonotus enigma* (Scudder), **the margined locust,** *Melanoplus marginatus* (Scudder), **the differential locust,** *M. differentialis* (Thomas), and **the yellow-winged or pellucid grasshopper,** *Camnula pellucida* (Scudder), have been most responsible for serious injury to grazing lands and crops in the state.

There was an invasion of **black crickets,** *Gryllus assimilis* (Fabr.), in the Santa Clara Valley in 1854 and a serious infestation of **the Mormon cricket,** *Anabrus simplex* Hald., was reported by E. M. Ehrhorn in July, 1891. A bait of flour and Paris green, ten to three, was recommended for their control. A slight infestation of **the valley cricket** (**long-legged grasshopper**), *Clinopleura melanopleura* (Scudder), occurred at Turlock, in 1904.[49]

The Jerusalem cricket, *Stenopelmatus*, sp. although never a pest was first figured and identified as the California mole cricket, *Gryllotalpa*, by S. S. Rathvon [50] in 1877 from a specimen taken in the Sacramento Valley and recorded as eating potatoes.

[48] U. S. Commr. Agr., *Rept. for 1885*, p. 297 (1886).
[49] Hunter, J. S., Calif. Agr. Expt. Sta., *Bul. 170*, p. 4 (1905).
[50] *Pacific Rural Press*, vol. 14, p. 217 (Oct. 6, 1877).

ISOPTERA (Order)

Termites

Native termites have, since the earliest days, been more or less destructive to building materials in California. Such species as **the minor termite,** *Kalotermes minor* (Hagen) (Fig. 47), and **Hubbard's termite,** *Kalotermes hubbardi* Banks, infested the wooden framework and rafters in the adobe huts of the Indians in the Southwest. The former also was taken from the Russian ruins of Fort Ross in 1927. After the occupation of the whites, these and other species became common pests of telephone poles, fence posts and pickets, buried wooden water pipes, and the foundations of barns and other buildings, particularly wherever wood came in contact with the earth.

In 1910 considerable termite injury to deciduous fruit trees was noted in southern California, particularly in the vicinity of Banning.[51]

Since then the subterranean species, and particularly **the western termite,** *Reticulitermes hesperus* Banks, has done considerable damage to fruit trees, grapevines, fence posts, and pickets, as well as to the foundations of buildings.

The first notable damage of termites to buildings occurred at Pasadena in August, 1926, and considerable misrepresentations were made regarding that outbreak. Subsequent inspections revealed the presence of termites in buildings throughout the state. In the southern part *Kalotermes minor* (Hagen) was the most important species involved, while in the north *Reticulitermes hesperus* Banks, and other related species, were involved.

To meet the great demands for protection against possible injury of known native species and possible introduced species, a Termite Investigations Committee,[52] organized at San Francisco,

[51] Prizer, J. A., *Calif. Cult.*, vol. 34, p. 603 (May 19, 1910), p. 702 (June 16, 1910). Cundiff, R. P., *ibid.*, vol. 34, p. 654 (June 2, 1910).

[52] This committee was organized largely through the efforts of C. A. Kofoid, and S. F. Light, Department of Zoölogy of the University of California and A. A. Brown, Engineer of the California-Hawaiian Sugar Refining Co., and was composed of an advisory committee appointed from the University of California by W. W. Campbell. Among this group were: C. A. Kofoid and S. F. Light, Dept. of Zoölogy, E. O. Essig, W. B. Herms, and E. C. Van Dyke, Division of Entomology, and E. D. Merrill, of the Department of Agriculture, and other technical advisors. It was further made up of representatives of all organizations which contributed to the financial resources of the committee. Many other names were added to the committee later from time to time.

August 1, 1928. This committee was composed of scientists of state institutions as consultants and advisors and from the public service and other organizations which contributed to the work of the committee. A program was outlined for three years and a sum of approximately $60,000 was set as a goal for financing the investigations throughout the Pacific slope. Certain field and laboratory assistants were employed by the committee to work under the personal direction of Kofoid, Light, and the chemical

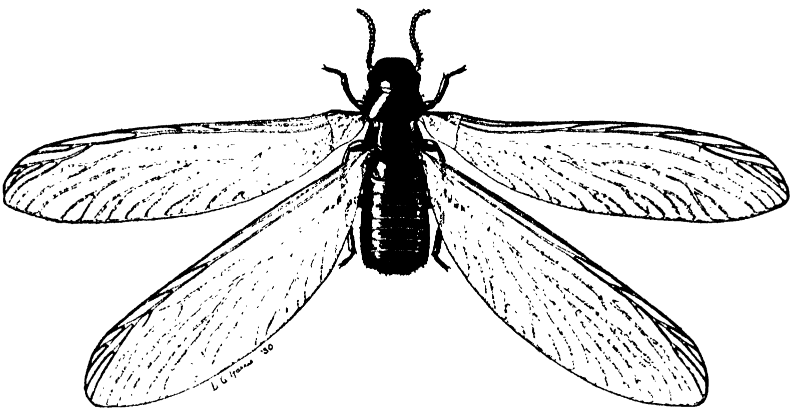

FIG. 47.—The winged sexual form of the minor drywood termite, *Kalotermes minor* (Hagen), taken from the old redwood timbers of the north bastion at Fort Ross, October 6, 1927. This species is one of the most destructive to posts, poles, and wooden structures, especially in the southern part of the state. $\times 7\frac{1}{2}$.

subcommittee. These men were to collect data, determine distribution and study the life histories and other phases of the insect and to furnish the basis for the work of the many subcommittees appointed to undertake the more practical means of preventing and controlling termites.

Two publications, originating with the committee are:

Light, S. F., *Termites and termite damage*, Calif. Agr. Exp. Sta., Circ. 314, 28 pp., 24 figs. (1929).

Report on the symposium on termite problems of the Termite Investigations Committee, September 2–13, 1929, Termite Investig. Com., S. F., 42 pp. (1929).

A thorough and complete work on the termites of California and the Southwest will be published by the investigators of this committee later on.

THYSANOPTERA (Order)

Thrips

The pear thrips, *Tæniothrips inconsequens* (Uzel) (Fig. 48), was originally described as *Physopus inconsequens* by Uzel[53] in 1895 from specimens taken on anemone, aspen, cherry, horse chestnut, and maple at Prague (Praha), Czechoslovakia and at Budapest (Pest), Hungary.

The insect attracted little or no attention as an economic pest until after its introduction into America, where it was apparently

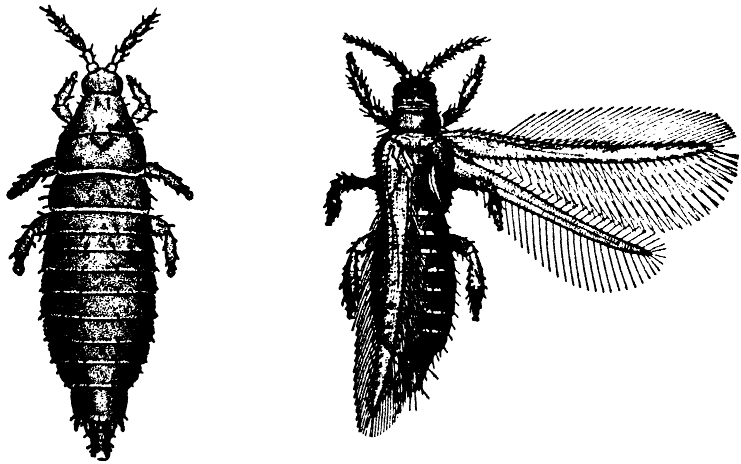

FIG. 48.—The pear thrips, *Tæniothrips inconsequens* (Uzel), as illustrated by Dudley Moulton in 1905. This insect was first described in Europe in 1895 and was undoubtedly introduced into North America on nursery stock. It was first noted in the Santa Clara Valley, California in 1902 and in the Hudson Valley, New York in 1911.

established independently in a number of different localities on European nursery stock. In California the pear thrips first attracted attention in the Santa Clara Valley in the spring of 1902 in a prune orchard near San José.[54] Ehrhorn[55] noted its appearance in the orchard of R. K. Thomas in the Santa Clara Valley in the spring of 1904. He referred to it as *Euthrips fuscus* and recorded his observations as follows: "One species, *Euthrips fuscus*, in particular has been very destructive to the buds and blossoms of

[53] Uzel, H., *Monographie der ordnung Thysanoptera*, Königgrätz (Hradci Kralove) Czech., pp. 117–119 (1895).

[54] Foster, S. W., and Jones, P. R., U. S. Dept. Agr., *Bul. 173*, p. 1 (1915).

[55] Ehrhorn, E. M., *1st Bien. Rept. Calif. State Hort. Com.*, 1903–1904, pp. 120–121 (1905).

prune, apricot, and peach trees in the Santa Clara Valley. The infested area is well marked, as the fruit did not set at all, and during the blossoming season each infested orchard presented a dismal look in contrast to the beautiful white blossoms of other sections. The damage done by this insect is first caused to the style of the blossom, which it punctures, so that fertilization can not take place; but if fertilization has taken place, then the injury will be noticed in the mature fruit, which is badly scarred, and this will serve as an indication to the grower that the insect is present on his trees. To what extent this pest will spread is difficult to say, but stringent measures should at once be taken to prevent it from gaining a strong foothold."

In 1904 S. M. Daniel,[56] a student at the University of California, described this thrips as a new species, *Euthrips pyri*, from specimens taken in pear blossoms at San Leandro, Alameda County, California. At the time Daniel knew nothing about the occurrence of the insect on prunes in the Santa Clara Valley, which accounts for her naming it *pyri*, which was followed by the common appellation pear thrips. The insect increased rapidly and became very destructive to prunes, pears, cherries, peaches, almond, plum, and other fruit trees throughout the San Francisco Bay region from 1904–1910. In 1905 Moulton [57] published the results of the first life history studies of this important insect and paved the way for the more intensive investigations which followed.

In 1907 the Bureau of Entomology established a laboratory at San José and conducted investigations and control of the pear thrips until 1915. The results of the researches have appeared in many splendid publications.[58] One of the products of these investigations was the development of the so-called government formula.[59]

[56] Daniel, S. M., *New California Thysanoptera*, Entom. News, vol. 15, pp. 294–295 (1904).

[57] Moulton, D., *The pear thrips*, Calif. State Hort. Com., 17 pp., 8 figs. (1905).

[58] Moulton, D., *The pear thrips*, U. S. Dept. Agr., Bur. Entom., Bul. 68, pt. i, pp. 1–16, 8 figs., 2 pls. (1907).

The Thysanoptera of California, ibid., Tech. ser. 12, pt. iii, pp. 53–54, pl. III, figs. 19–24 (1907).

The pear thrips and its control, ibid., Bul. 80, pt. iv, pp. 51–66, figs. 13–17, pls. iv–vi (1909).

Foster, S. W., and Jones, P. R., *How to control the pear thrips*, U. S. Dept. Agr., Bur. Entom., Circ. 131, 24 pp., 15 figs. (1911).

The life history and habits of the pear thrips in California, U. S. Dept. Agr., Bul. 173, 52 pp., 14 figs., 5 pls. (April 13, 1915).

[59] This consisted of a 3 per cent distillate oil emulsion, to which was added from 1 per cent to 1 $^2/_3$ per cent tobacco extract containing 2 ¾ per cent nicotine or by

In 1910–1911, Morris[60] developed the whitewash method of controlling this insect and in 1919–1920 the writer[61] showed that nicotine dusts were also satisfactory for the control of the pest. In 1916[62] the insect occurred in the counties of San Mateo, Santa Clara, San Benito, Alameda, Contra Costa, San Francisco, San Joaquin, Solano, Sacramento, Yolo, Napa, Marin, and Sonoma. This area has not materially changed since that time. Up to 1922 the pear thrips was an important economic insect in these counties and required regular control, but since then it has appeared irregularly and usually in small areas. It has perhaps been most troublesome in late years in Napa and Sonoma counties. This general decline in the destructiveness of the insect may be due to improved cultural methods—cultivation, irrigation, and the use of a cover crop—because it appears most injurious in non-irrigated orchards and where cover crops are not successful. It is at present controlled either with sprays or dusts.[63]

In 1911 the pear thrips was first noted in the Hudson Valley, New York.[64] By 1915 it had become quite serious, but was well under control by 1920.[65]

In 1914 Hood[66] placed the species in the genus *Tæniothrips* and it became known as *T. pyri* (Daniel).

In other parts of North America the pear thrips was first noted as follows:

> Maryland—near Baltimore, April 25, 1913 by Scott[67] who found pear trees swarming with the insects.

adding 40 per cent nicotine sulfate at the rate of 1 part to from 1,500 to 2,000 parts of the oil spray. G. E. Merrill, Calif. State Hort. Com., *Mthly. Bul.*, vol. 1, p. 54 (1912).

[60] Morris, Earl, *Pear thrips and peach tree borer*, Calif. Agr. Exp. Sta., Bul. 228, pp. 367–371, figs. 1–4 (1912).

[61] Essig, E. O., *The pear thrips*, *ibid.*, Circ. 223, 9 pp., 3 figs. (1920).

[62] Essig, E. O., *Injurious and beneficial insects of California*, pp. 35–37, fig. 32 (1913); ed. 2, pp. 56–58, fig. 49 (1915); Calif. State Hort. Com., *Mthly. Bul.*, vol. 5, p. 117, fig. 45 (1916). Map showing distribution in California.
Insects of Western North America, pp. 189–190 (1926).

[63] Herbert, F. B., *Rapid spraying versus dusting in thrips control*, Jour. Econ. Entom., vol. 20, pp. 665–667 (1927).

[64] Parrott, P. J., *Science*, n. s., vol. 34, p. 94 (1911); *The pear thrips*, N. Y. Agr. Exp. Sta., Bul. 343, 28 pp., 5 figs., 3 pls., 1 col. pl. (1912).

[65] Phipps, C. R., *Control of pear thrips*, *ibid.*, Bul. 484, 11 pp., 2 figs., 5 pls. (Jan., 1921).

[66] Hood, J. D., *Proc. Wash. Entom. Soc.*, vol. 16, pp. 34–44 (1914).

[67] Scott, W. M., *The California pear thrips in Maryland*, Jour. Econ. Entom., vol. 7, pp. 478–479 (1914).

British Columbia—at Royal Oak, Vancouver Island, April, 1915.[68]
Ontario—near Beamsville, 1918.[69]
Oregon—near Salem, 1919.[70]

It has also been found in Pennsylvania.

In Europe there has been a revival of interest in this insect. In 1912 Karny [71] placed it in the genus *Physothrips* and in 1916 Williams [72] showed that *T. pyri* (Daniel) was a synonym of *T. inconsequens* (Uzel). He pointed out the fact that whereas only females were found in America, both sexes occurred in Europe and that the insect spends about 10 months in the larval and pupal stages in the soil. This habit I think is responsible for its distribution on nursery stock. In 1912 it was discovered on apples and pears in Crimea, Russia.[73] In 1924 it appeared in Germany [74] and also occurred in England, Denmark, Norway, and Bohemia.

It is also reported from Argentina in 1925.[75]

HOMOPTERA (Order)

CICADELLIDÆ (Family). Leafhoppers.

The grape leafhopper, *Erythroneura comes* (Say) (Fig. 49), is recorded as a pest of grapes in California as early as 1863 in Sonoma County and was a pest in 1864–65.[76] In 1868 it was also recorded as a pest of grapes by T. F. Cronise,[77] who stated that " The grape fly has taken possession of the vines in several localities. It is a species of microscopic grasshopper which has always fed on alfilerilla grass, and now shows preference for the grape leaf. By day it lies concealed and sheltered from the sun on the under side of the leaf. At night it feeds on the upper part of the leaf. The leaf is the

[68] Hewitt, C. G., *Agr. Gaz. Canada*, vol. 2, pp. 732–737, 4 figs. (Aug. 8, 1915).
Cameron, A. E., and Treherne, R. C., *The pear thrips in British Columbia and its control*, *ibid.*, vol. 3, pp. 946–951, 4 figs. (Nov., 1916); vol. 4, pp. 13–16 (Jan., 1917).
Treherne, R. C., *Proc. Entom. Soc. British Columbia*, no. 9, pp. 80–82 (Aug., 1916); *Can. Entom.*, vol. 51, pp. 185-188, 1 pl. (1919).

[69] Ross, W. A., *Can. Entom.*, vol. 51, p. 85 (1919).
Ross, W. A., and Cæsar, L., *49th Rept. Entom. Soc. Ontario*, 1918, p. 24 (1919).

[70] Lovett, A. L., *The pear thrips*, Ore. Agr. Expt. Sta., 3d Crop Pest and Hort. Rept., 1915–1920, pp. 95–102, figs. 21–26 (1921).

[71] Karny, H. H., *Zoöl. Ann.*, vol. 4, p. 338 (1912).

[72] Williams, C. B., *Entom.*, vol. 49, pp. 278–280 (1916).

[73] *Review of Appld. Entom.*, Ser. A, Agr., vol. 2, p. 198 (1914).

[74] Zacher, F., *Der birnenblasenfuss* (Tæniothrips inconsequens *Uzel*—Euthrips pyri *Daniel*), *ein neuer deutscher obstschädling*, *Nachrichtenblatt deutsch.* Pflanzenschulzdienst, Berlin, vol. 4, pp. 29–30, 3 figs. (May 1, 1924).

[75] *Rev. Appld. Entom:* Ser. A, Agr., vol. 14, p. 85 (1926).

[76] Morse, F. W., College of Agr., Univ. of Calif., *Rept. for 1880*, p. 93 (1881).

[77] *The Natural Wealth of California*, pp. 373–374 (1868).

lung of the plant, and soon its destruction causes the fruit to wither. The vine itself will certainly yield to this life-sapping process; but the evil is not yet wide-spread enough to arouse public attention to devise a remedy."

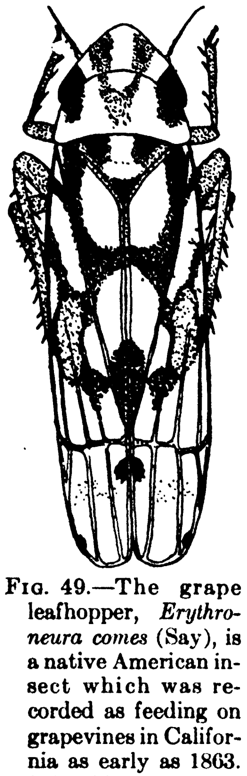

FIG. 49.—The grape leafhopper, *Erythroneura comes* (Say), is a native American insect which was recorded as feeding on grapevines in California as early as 1863. It is still a major pest of grapes in many localities throughout the country. (After H. J. Quayle, 1908.)

It was present in Fresno County in 1879 and in Placer County in 1880 and is referred to in the Pacific Rural Press in the issue of April 12, 1879,[78] and again in 1880.[79] Insect powder or buhach (pyrethrum) was suggested as a means of control in 1881. It was applied with a pepper box. In 1883 R. B. Blowers, of Woodland, controlled this pest with the following mixture: "In a fifty gallon barrel put thirty pounds of whale oil soap and fifteen pounds sulfur and mix it up thoroughly. Then add water until the barrel is nearly full, and allow it to remain one day without anything else being done to it, except stirring it two or three times. The object of this is to allow the ingredients to be completely blended together, so as to form one homogeneous mixture. The next day take three pailfuls of this mixture and six of water, or in that proportion, (1 to 2) until a barrel is filled containing forty or forty-five gallons. Then just previous to using add three quarters of a pound of buhach, and mix thoroughly. After the addition of the buhach it should be applied immediately."[80] C. W. Woodworth issued a bulletin covering this insect in 1897[81] in which he recommended "the insect sweeping net during the summer as a practical means for controlling the grape leafhopper."

H. J. Quayle[82] in 1908 issued the most complete treatise on this

[78] Quayle, H. J., *The Grape Leaf-Hopper*, Calif. Agr. Expt. Sta., Bul. 198, p. 178 (1908).

[79] *Pacific Rural Press*, vol. 20, p. 104 (Aug. 14), p. 120 (Aug. 21, 1880).

[80] Cooke, Matthew, *Injurious insects of the orchard, vineyard, etc.*, pp. 380–381 (1883).

[81] Calif. Agr. Expt. Sta., *Bul. 116*, pp. 12–14 (1897).

[82] Calif. Agr. Expt. Sta., *Bul. 198*, pp. 177–216 (1908).

pest in California. In this he states: "With the exception of the phylloxera, the vine hopper is undoubtedly the most destructive insect pest of the vine in the state." At that time it occurred in all the important grape growing sections of the state and was particularly abundant in 1907. "The most satisfactory control method tried during the past two years (1907 and 1908) was the use of the screen cage" in which about 85 to 95 per cent of the adults were captured in the spring before the eggs were laid. Spraying with whale oil soap solution and resin wash to kill the nymphs was also recommended. This bulletin was followed by a circular in 1915 on Spraying for the Grape Leaf-Hopper [83] in which a spray composed of 1 pint of Blackleaf 40, $\frac{1}{3}$ gallon of liquid soap (or 2 pounds of hard soap) and 200 gallons of water was found to be very effective. Various mechanical suction devices were tried as late as 1914. Nicotine dust was first used in 1921 and dusts charged with from 2 to 3 per cent of pure nicotine killed the nymphs and some adults. Cyanide dust was introduced in 1923 and although reported to be the best insecticide so far experimented with in the control of this pest, it does not always kill the nymphs and adults however easily and quickly applied. The application of this dust by means of airplanes was tried experimentally in May and June, 1930, but as yet no definite conclusions as to the efficacy of the method have been arrived at.

The beet leafhopper, *Eutettix tenellus* (Baker),[84] was described as *Thamnotettix tenella* by Baker in 1896 from a single female collected at Las Cruces, Colorado, on *Sisymbrium* and previously mentioned in 1895.[85] It was said by Baker to be quite a common insect in various parts of Colorado. No economic significance was connected with the insect at that time.

In June, 1899, a serious, mysterious disease known as California beet blight, western blight, curly top and curly leaf spread over several of the sugar beet districts in California and caused considerable losses to the crop at Spreckles, Kings City, Santa Maria, Alvarado, and Suisun. It diminished to reappear serious again in 1900, when it was observed most injurious in the hotter areas where sugar beets were grown. In this year also it was noted in

[83] Quayle, H. J., Calif. Agr. Expt. Sta., *Circ. 126*, p. 6 (1915).
[84] Baker, C. F., *Psyche*, vol. 7, suppl., pp. 24–25 (March, April, 1896), (*Thamnotettix tenella* Baker).
[85] Gillette, C. P., and Baker, C. F., *Prelim. list of the Hemiptera of Colorado*, Colo. Agr. Expt. Sta., Bul. 31, p. 100 (1895).

Chino, Los Alamitos, and Oxnard. It again diminished until another flare-up occurred in 1905. During the period from 1899 to 1905 many experts in America and in Europe were called upon to investigate and report upon the nature and cause of the disease. Among those who looked into the matter were E. M. Ehrhorn, Gustav Eisen, H. H. Behr, Albert Kœbele, H. Mendelsohn,

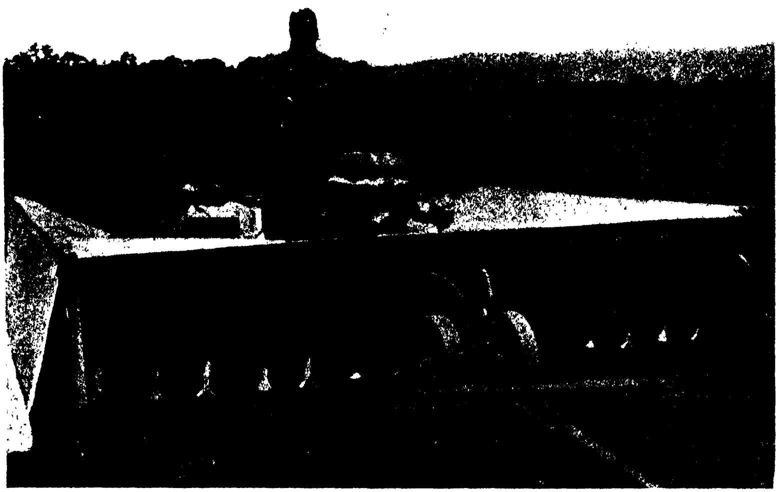

FIG. 50.—A power dusting machine designed for controlling the beet leafhopper, *Euttetix tenellus* (Baker), in the Salinas Valley, California. Although the duster was a success, the costs of the number of applications necessary to prevent the curly leaf were prohibitive. (After H. H. P. Severin, 1921.)

N. W. Pierce, E. J. Wickson, R. E. Smith, E. E. Smith, C. O. Townsend, R. L. Adams, A. Wilhelmj, Schneider, A. Herzfeld (Berlin), Linhart (Hungary), Hallrung (Halle), Bruns Steglich (Dresden). Many guesses were made as to the cause of the disease. Aphis, coccids, fungi, bacteria, soil conditions, climate, etc., were claimed responsible.

In 1905, E. D. Ball in Utah suspected the beet leafhopper, *Eutettix tenellus* (Baker), as being the cause of "the unhealthy condition called 'curly leaf' or 'blight' in that state."

C. O. Townsend, pathologist in charge of sugar beet investigations, Bureau of Plant Industry, U. S. Department of Agricul-

ture, expressed his opinions regarding the disease in 1908 as follows: [86]

> Curly-top is not identical with any disease of the beet previously described, except possibly that described from Indiana.
>
> It is a distinct disease with well-marked symptoms.
>
> It has not been reported with certainty from any country other than the United States.
>
> It has thus far been confined to the middle and western parts of this country.
>
> It is capable of appearing under a great variety of soil and climatic conditions.
>
> It does not seem to be produced by any one abnormal condition of soil or climate.
>
> It does not seem to be due to any parasite isolated thus far.
>
> It does not seem to be due to the condition of the seed.
>
> It attacks stock and garden beets as well as sugar beets.
>
> It is not limited to beets of any particular age.
>
> It does not seem to be communicated directly from beet to beet.
>
> It has not appeared to any serious extent two years in succession in the same locality.
>
> There are indications that a strain of beets resistant to curly-top may be developed.
>
> Growers need not hesitate to plant beets in a field even though their entire crop of beets in that field was destroyed by curly-top the preceding year.

One of Townsend's men, H. B. Shaw, working on the suggestion of Ball, was the first to experimentally prove the beet leafhopper to be the causal agent of curly top in 1910.[87]

In the meantime Ball continued his investigations of the sugar beet leafhopper and in 1917 published a confirmation of his former statements and offered proofs to substantiate his claims.

Then followed a vast amount of scientific research work to verify the statements made by Ball and others and to offer a solution of the problem of sugar beet production in areas infested by this destructive insect.

Ball continued his work for the Bureau of Entomology, and C. F. Stahl and E. Carsner were later detailed on the problem in the Bureau. H. H. P. Severin in 1917 begin an intensive study of all phases of the insect and the disease for the Agricultural Experiment Station, University of California, and has continued on the problem until the present time. During the past two years he has

[86] Townsend, C. O., U. S. Dept. Agr., Bur. Plant Ind., *Bul. 122*, p. 32 (1908).

[87] Shaw, H. B., *The curly-top of beets*, U. S. Dept. Agr., Bur. Plant Ind., Bul. 181, 46 pp., 9 figs., 9 pls. (1910).

Rand, F. V., and Pierce, W. D., *A coördination of our knowledge of insect transmission in plant and animal diseases*, Phytopath., vol. 10, p. 216 (1920).

been ably assisted by Olive Swezy, who has been studying the possible organisms responsible for the disease. W. Carter also took up investigational work on the beet leafhopper for the Bureau of Entomology and C. F. Henderson joined him late in 1928. A number of investigators have also been employed by the sugar companies. Asa C. Maxson, in charge of the Experimental Department, Great Western Sugar Company, Colorado, published an extensive work on sugar beet insects in 1920 [88] which contained an account of the beet leafhopper. Clean culture was the method of control recommended.

In 1921 Severin found that the insect could be killed by frequent dustings with nicotine dusts, but that the cost was prohibitive (Fig. 50), and in 1928 Schwing recommended spraying and trapping on pre-irrigated sugar beet patches. No practical methods of dealing with the problem were discovered by any of the investigators.

In view of the difficulty of artificial control it was decided to try the biological method of control in California. This seemed hopeless to many of the entomologists who were familiar with the problem, but upon the very urgent requests of the sugar beet interests, which raised sufficient funds to pay the traveling expenses of a field collector, the work was undertaken by the State Department of Agriculture and later by the University of California. E. J. Vosler made two trips to Australia: one in 1917 and the other in 1918 in the hopes of finding a suitable natural enemy there, but he was unsuccessful (see further account of these trips, pp. 380–381).

This first attempt was followed by the coöperative efforts of the University of California and the Bureau of Entomology, in sending C. F. Henderson to the Argentine Republic in 1926–1927, and to Mexico, Lower California and certain of the western states in 1927–1928. No parasites of value were found in South America. A considerable number of natural enemies were found in Mexico, but none which did not already occur within the limits of the distribution of the beet leafhopper in the Western States. Therefore, no importations of parasites were made (also see pp. 382–383).

At this writing the exact organism causing the disease remains

[88] *Principal insect enemies of the sugar beet*, Agr. Dept. Great Western Sugar Co., Denver, Colo., 157 pp., 30 figs., 9 col. pls. (1920) (Beet leafhopper, pp. 123–128, figs. 25–26).

a mystery, although the transmission of the disease by the beet leafhopper has been thoroughly studied and appears to be well understood. One of the important results in the studies of this problem has been the methods devised which are applicable for the study of the many insects responsible for the transmission of plant and animal diseases. H. H. P. Severin, C. F. Stahl, E. Carsner, Olive Swezy, and W. Carter have been the leaders in developing these.

In the spring of 1929 the U. S. Department of Agriculture assigned six investigators, three in plant pathology with Carsner as the leader and three in entomology under Carter. The latter were W. Carter, C. F. Henderson, and Joseph C. Chamberlin.

The more important articles dealing with this insect are:

Adams, R. L., *The California beet blight*, Univ. Calif., M. S. Thesis (1909) (not published).

Townsend, C. O., *Some diseases of the sugar beet in progress of beet sugar industry in the U. S.*, U. S. Dept. Agr., Rept. 72, pp. 93–95 (1901).

Curly-top, a disease of the sugar beet, U. S. Dept. Agr., Bur. Plant Ind., Bul. 122, 37 pp., 11 pls. (1908).

Shaw, H. B., *The curly top of beets*, U. S. Dept. Agr., Bur. Plant Ind., Bul. 181, 46 pp., 9 figs., 9 pls. (1910) (Bibliography).

Ball, E. D., *The beet leafhopper*, Utah Agr. Exp. Sta., 16th Rept., p. xvi (1906).

Leafhoppers of the sugar beet and their relation to the "curly-leaf" condition, U. S. Dept. Agr., Bur. Entom., Bul. 66, pt. iv, pp. 33–52, 4 pls. (1909).

The beet leafhopper and the curly-leaf disease that it transmits, Utah Agr. Expt. Sta., Bul. 155, 56 pp., 5 figs., 5 pls. (1917).

Smith, R. E., and Boncquet, P. A., *New light on curly-top of the sugar beet*, Phytopathology, vol. 5, pp. 103, 107, fig. (1915).

Connection of a bacterial organism with curly-leaf of the sugar beet, *ibid.*, pp. 335–342, pl. (1915).

Boncquet, P. A., *Discovery of curly leaf of sugar beets in the Argentine Republic*, Phytopath., vol. 13, pp. 458–460 (1923).

Hartung, W. J., and Severin, H. H. P., *Natural enemies of the sugar beet leafhoppers in California*, Calif. State Hort. Com., Mthly. Bul., vol. 4, pp. 277–280 (1915).

Severin, H. H. P., *Notes on the beet leafhopper*, Eutettix tenella *Baker*, Jour. Econ. Entom., vol. 11, no. 3, pp. 308–312 (1918).

Beet leafhopper, The, A report on investigations into its occurrence in California, Facts about Sugar, vol. 8, no. 7, pp. 130–131, 134; no. 8, pp. 150–151; no. 9, pp. 170–171, 173; no. 10, pp. 190–191; no. 11, pp. 210–211; no. 12, pp. 230–231; no. 13, pp. 250–255; figs. 1–8 (1919).

The beet leafhopper (Eutettix tenella *Baker*), Calif. Agr. Expt. Sta., Ann. Rept., p. 70 (1919).

Notes on the behavior of the beet leafhopper (Eutettix tenella *Baker*), Jour. Econ. Entom., vol. 12, no. 4, pp. 303–308 (1919).

Investigations of the beet leafhopper (Eutettix tenella *Baker*) in California, Jour. Econ. Entom., vol. 12, no. 4, pp. 312–326, pl. 15 (1919).

The beet leafhopper—Beet blight, Calif. Agr. Expt. Sta., Ann. Rept., pp. 60, 62–63 (1920).

Practical use of curly leaf symptoms, Facts about Sugar, vol. 12, no. 9, pp. 170–171, 173; no. 11, pp. 212–214, 217, figs. 1–25 (1921).

Sugar beet blight transmitted by the insect, Eutettix tenella *Baker*. *The beet leafhopper* (Eutettix tenella *Baker*), Calif. Agr. Exp. Sta., Ann. Rept., pp. 41–42 (1921).

Minimum incubation periods of causative agent of curly leaf in beet leafhopper and sugar beet, Phytopath., vol. 11, no. 10, pp. 424–429, figs. 1–4 (1921).

Experiments with a dusting machine to control the beet leafhopper (Eutettix tenella *Baker*) *with nicotine dust* (with W. J. Hartung and E. A. Schwing), Jour. Econ. Entom., vol. 14, no. 5, pp. 405–410, pl. 5 (1921).

Summary of the life history of the beet leafhopper (Eutettix tenella *Baker*), Jour. Econ. Entom., vol. 14, no. 5, pp. 433–436 (1921).

Minimum incubation periods of causative agent of curly leaf in beet leafhopper and sugar beet, Summary, Phytopath., vol. 12, no. 2, p. 105 (1922).

The life history of the beet leafhopper. A record from studies of Eutettix tenella *conducted in the San Joaquin Valley, California*, Facts about Sugar, vol. 14, no. 5, pp. 92–93; no. 6, pp. 110–111; no. 7, pp. 130–131; no. 8, pp. 152–158; no. 9, pp. 170–171; figs. 1–16 (1922).

Control of the beet leafhopper. Is it economically a hopeless problem in California? Facts about Sugar, vol. 14, no. 16, pp. 312–313; no. 17, pp. 332–333 (1922).

Curly leaf transmission experiments with beet leafhopper (Eutettix tenella *Baker*). Summary, Jour. Econ. Entom., vol. 15, no. 2, p. 182 (1922).

Mosaic and curly leaf diseases of sugar beets, Jour. Econ. Entom., vol. 15, no. 3, p. 247 (1922).

Relation of leafhopper migrations to time of sugar beet planting. Use of nicotine dust against the beet leafhopper, Eutettix tenella *Baker*. *Curly leaf transmission experiments with beet leafhopper*, Calif. Agr. Exp. Sta., Ann. Rept., pp. 83–85, fig. 25 (1922).

Control of the beet leafhopper. Experiments in the use of nicotine dust with a dusting machine conducted in California. Facts about Sugar, vol. 15, no. 7, pp. 134–135, 137, figs. 1–6 (1922).

Infective beet leafhoppers (Eutettix tenella *Baker*) *do not transmit curly leaf daily*, Jour. Econ. Entom., vol. 15, no. 7, p. 318 (1922).

Facts concerning migration of beet leafhopper (Eutettix tenella *Baker*) *in Sacramento Valley of California*, Jour. Econ. Entom., vol. 15, no. 6, pp. 404–411 (1922).

Facts concerning natural breeding area of beet leafhopper (Eutettix tenella *Baker*) *in San Joaquin Valley of California*, Jour. Econ. Entom., vol. 15, no. 6, pp. 411–419 (1922).

Natural enemies of beet leafhopper (Eutettix tenella *Baker*); *curly leaf*

transmission experiments, chemical substances or toxin, incubation period, Calif. Agr. Expt. Sta., Ann. Rept., pp. 125–128, 1 fig. (1923).

Investigation of beet leafhopper (Eutettix tenella *Baker*) *in Salinas Valley of California,* Jour. Econ. Entom., vol. 16, no. 6, pp. 479–485 (1923).

Curly leaf transmission experiments, Phytopath., vol. 14, no. 2, pp. 80–93, Abstr., p. 123 (1923).

Natural enemies of beet leafhopper (Eutettix tenella *Baker*), Jour. Econ. Entom., vol. 17, no. 3, pp. 369–377 (1924).

Causes of fluctuation in numbers of beet leafhoppers (Eutettix tenella *Baker*) *in a natural breeding area of the San Joaquin Valley of California,* Jour. Econ. Entom., vol. 17, no. 6, pp. 639–645 (1924).

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Percentage of curly leaf infection in beet leafhopper (Eutettix tenella *Baker*) *and winter host plants under field conditions,* Jour. Econ. Entom., vol. 18, no. 5, pp. 733–737 (1925).

The 1925 outbreak of beet leafhopper, Eutettix tenella *Baker, in California* (with E. A. Schwing), Jour. Econ. Entom., vol. 19, pp. 478–483 (1926).

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Curly top symptoms on the sugar beet, Calif. Agr. Expt. Sta., Bul. 465, 35 pp., 13 figs., 4 pls. (1929).

Severin, H. H. P., and Henderson, Chas. F., *Beet leafhopper,* Eutettix tenellus (*Baker*) *does not occur in the Argentine Republic,* Jour. Econ. Entom., vol. 21, pp. 542–544 (1928).

Henderson, Chas. F., *Exploration in the Argentine Republic for parasites of the beet leafhopper,* Eutettix tenellus (*Baker*), *ibid.*, vol. 21, pp. 863–871, fig. 59 (1928).

Boncquet, P. A., and Stahl, C. F., *Wild vegetation as a source of curly-top infection of sugar beets, ibid.*, vol. 10, pp. 392–397, pls. 17–18 (1917).

Stahl, C. F., and Carsner, E., *Obtaining beet leafhoppers nonvirulent as to curly-top,* Jour. Agr. Research, vol. 14, pp. 393–394 (1918).

Stahl, C. F., *Studies on the life history and habits of the beet leafhopper, ibid.*, vol. 20, pp. 245–252, pl. 43 (1920).

Stahl, C. F., and Carsner, E., *A discussion of* Eutettix tenella *Baker as a carrier of curly-top of sugar beets,* Jour. Econ. Entom., vol. 16, pp. 476–479 (1923).

Carsner, E., *Attenuation of the virus of sugar beet curly-top,* Phytopath., vol. 15, pp. 745–757 (1925).

Resistance in sugar beets to curly-top, U. S. Dept. Agr. Circ. 388, 7 pp. (1926).

A technic for use with homopterous vectors of plant disease, with special reference to the sugar beet leafhopper, Eutettix tenellus (*Baker*), Jour. Agr. Research, vol. 34, pp. 449–451 (1927).

Vosler, E. J., *Some work of the Insectary Division in connection with the at-*

tempted introduction of natural enemies of the beet leafhopper, Calif. State Hort. Com., Mthly. Bul., vol. 8, pp. 231–239, figs. 96–103 (1919).
Rand, F. V., and Pierce, W. D., *A coördination of our knowledge of insect transmission in plant and animal diseases*, Phytopath., vol. 10, pp. 190–231 (1920) (complete bibliography).
Schwing, E. A., and Hartung, W. J., *Utilization of systematic observations on beet leafhopper* (Eutettix tenella *Baker*) *and curly leaf of sugar beets*, Jour. Econ. Entom., vol. 15, pp. 365–368 (1922).
Schwing, E. A., *Experiments on the control of* Eutettix tenellus (*Baker*), *ibid.*, vol. 21, pp. 790–791 (1928).
De Long, D. M., *The occurrence of the beet leafhopper* (Eutettix tenella *Baker*) *in eastern U. S.*, *ibid.*, vol. 18, pp. 637–638 (1925).
Davis, E. W., *Notes on collections of the sugar beet leafhopper showing the extension of its known range into British Columbia and to the coast in Washington and Oregon*, *ibid.*, vol. 20, pp. 581–586, fig. 22 (1927).
Carter, W., *Extensions of the known range of* Eutettix tenellus *Baker and the curly-top of sugar beets*, *ibid.*, vol. 20, pp. 714–717 (1927).
Knowlton, G. F., *The beet leafhopper and curly-top situation in Utah*, Utah Agr. Exp. Sta., Circ. 67, 12 pp., 6 figs. (1927).
The beet leafhopper in Utah, *ibid.*, Bul. 205, 23 pp., 9 figs. (1928).

PHYLLOXERIDÆ (Family). Phylloxera.

The grape phylloxera. The first serious entomological problem in California, aside from grasshoppers, was the grape phylloxera, *Phylloxera vitifoliæ* Fitch, which is thought to have been introduced on rooted varieties of the American grapes probably from the Eastern States in 1858. At that time, anyway, a considerable planting of Catawba and other varieties of American grapes was made where phylloxera was later discovered.

A malady which killed many grapevines at Sonoma in 1860 has been ascribed to this insect. In connection with the introduction of the phylloxera into California it should be pointed out that in 1861, Agoston Haraszthy was "appointed by the Governor of California as a commissioner to visit the wine countries of Europe which resulted in the importation of 300 different named varieties of wine grapes." [89] Haraszthy organized the Buena Vista

[89] Menefee, C. A., *Historical and descriptive sketch of Napa, Sonoma, Lake and Mendocino Counties, etc.* (Napa, Calif., 1873), p. 289.

According to Gustav Eisen, Haraszthy imported the Muscat of Alexandria on March 24, 1852, and ten years later, during a visit to that place on September 27, 1861, he selected cuttings of Gordo Blanco and also imported Sultana vines from Malaga and red and white Corinth from Crimea in the same year. Thus he was the first to introduce raisin grapes into California [*The raisin industry, etc.* (S. F., H. S. Crocker & Co., 1890), p. 38].

Bremner, O. E., *Observations on Phylloxera*, Proc. 30th Calif. State Fruit-Growers' Conv., Calif. State Hort. Com., pp. 337–343 (1905).

Company in 1863, where the phylloxera was definitely found in 1874.[90] This vineyard at that time comprised 500 acres and was the largest in the state, and was situated "four miles beyond Sonoma in the Wohler neighborhood." Prior to this discovery, the California press had given considerable space to comments on the phylloxera situation in France. In 1871 attention was called to the fact that the insect was suspected of being American in origin and carried to France on the Catawba grape,[91] and in 1874 the reward of $60,000 offered for an effectual cure in France was discussed.[92] It seems strange, therefore, that although the vineyardists of California were familiar with the depredations of this insect in France, they were not fully alive to the seriousness of its presence in California. A bill providing for an appropriation to destroy the phylloxera was introduced into the Assembly of the California State Legislature in the spring of 1876, but failed to receive sufficient support to become a law. In July of the same year E. W. Hilgard, Director of the State Agricultural Experiment Station, who was tremendously interested in the problem, published an article in the Pacific Rural Press,[93] in which he urged interest in the phylloxera situation. After this the interest waned until Hilgard spoke at a meeting of viticulturists held at Sonoma, Saturday, November 23, 1878,[94] at which time considerable concern was manifested. At this meeting it was suggested that bricks saturated with CS_2 and afterwards varnished to prevent rapid escape of the gas be buried three inches deep in the soil near each vine. Flooding was, however, the general method recommended, but was of no avail where vines were on hilly or rolling ground.

In July, 1878, E. J. Wickson, editor of the Pacific Rural Press, offered to make "free examinations of leaves, sticks and roots of grape vines to determine the presence of phylloxera." [95]

The entire front page of the Pacific Rural Press for March 29, 1879, was devoted to Riley's illustrations and remarks concerning

[90] Hilgard, E. W., *Pacific Rural Press*, vol. 10, p. 275 (Oct. 30, 1875).

It is also stated that the phylloxera was discovered late in September, 1875, and examined by James Blake at Sonoma [*Proc. Calif. Acad. Sci.*, vol. 6, pp. 180–182 (1875)]. Blake proposed carbon disulfide as a remedy in 1876 [*Proc. Calif. Acad. Sci.*, vol. 7, pp. 122–126 (1876)].

[91] *Pacific Rural Press*, vol. 2, p. 262 (Oct. 28, 1871).

[92] *Ibid.*, vol. 8, p. 290 (Nov. 7, 1874).

[93] *Ibid.*, vol. 12, p. 58 (July 22, 1876).

[94] *Ibid.*, vol. 16, p. 338 (Nov. 30, 1878).

[95] *Ibid.*, vol. 16, p. 40 (July 20, 1878).

the life history of the phylloxera under eastern conditions. Vines were now being killed rapidly in Napa, Solano and Placer counties and hundreds of acres were already pulled up in Sonoma County. In 1880 Herman Behr gave a lecture on this insect before the Sonoma meeting of the State Board of Viticultural Commissioners in which he emphasized three points in control: (1) keep infested vines isolated; (2) befriend the spiders, protect their webs; (3) kill the ants.[96]

It soon became apparent that the phylloxera did not behave the same in California as it did in the eastern states. The almost complete absence of the sexual winged forms and leaf galls was apparent from the first. In 1880 fertile winged females were noted at Santa Rosa.[97] F. W. Morse of the University of California was delegated by Hilgard to make a survey of the vineyards throughout the state in 1880–81 to ascertain the extent of phylloxera infestation. He reported it in Sonoma, Napa, Solano, Yolo, Placer, Fresno, and Eldorado counties.[98] It was found in the experimental grape plots in Berkeley in 1880. In 1884–85 Morse also determined the chief points in the life history of the insect in California and succeeded in finding a few leaf galls,[99] but in the main he worked the salient points as they are known today and found that the species is distributed chiefly during the summer and fall by the wingless parthenogenetic females.

The State Legislature in 1880 passed an act for the Promotion of Viticultural Industries of the State which was approved April 15, 1880. This provided for nine commissioners to be appointed by the Governor, but did not provide for field workers or other expenses. Accordingly a new act to define and enlarge the duties and powers of the Board of State Viticultural Commissioners, and to authorize the appointment of certain officers, and to protect the interest of horticulture and viticulture was passed and approved March 4, 1881. It provided for a Chief Executive Viticultural and Health Officer and a Chief Executive Horticultural and Health

[96] *Ibid.*, vol. 20, p. 66 (July 31, 1880).

[97] *Ibid.*, vol. 20, p. 104 (Aug. 14); p. 120 (Aug. 21); p. 136 (Aug. 28, 1880).
Hilgard, E. W., *The Phylloxera or grapevine louse and remedies for its ravages*, Calif. College of Agr. Rept., Suppl. 1, pp. 1–25, 9 figs. (1880).

[98] *Pacific Rural Press*, vol. 21, p. 115 (Feb. 19, 1881).
Rept. on the occurrence of Phylloxera in California, Calif. College of Agr., Rept. for 1880, Append. no. 9, pp. 92–108 (1881).

[99] Calif. Agr. Expt. Sta., *Bul. 19* (1884); *ibid.*, *Bul. 34* (1885); Calif. College of Agr., *Rept.*, 1883–84 and 1884–85, pp. 164–204, 205–210 (1886).

Officer to be appointed by the Board at a salary not to exceed $150 per month, with traveling expenses not to exceed $500 a year, each. C. A. Wetmore was appointed Chief Executive Viticultural and Health Officer and at once formulated quarantine

FIG. 51.—A colony of the radicicole or root-inhabiting forms of the grape phylloxera, *Phylloxera vitifoliæ* Fitch, including adult females, eggs, and young, on a grape root in October. This is the dominant form of the insect in California. The phylloxera was described by Fitch in New York in 1855 and was first noted in California in 1874. In spite of its long residence in this state only a small percentage of the grapevines now grown in California are on resistant rootstocks.

regulations providing for the treatment and disinfection of cuttings of grapevines, rooted grapevines imported from any region outside of the state by any one of the six prescribed methods:

(1) Sulfo-carbonate potash 10 lbs. to 100 gals. of water. Immerse for 15 minutes.

(2) Little's soluble phenyle 1 gal. to 50 gals. of water. Immerse for 10 minutes.

(3) Prepare a dip by boiling together for one hour

Heavy oil of coal tar	2 parts
Carbonate of potash or carbonate of soda	1 part
Water	2 parts

Dilute 1 part to 50 parts of water and immerse for 10 minutes.

(4) Carbolic acid crystals 1 lb. to 20 gals. of water. Immerse for 10 minutes.
(5) Sulfide of potash 1 lb. to 20 gals. of water. Immerse for 20 minutes.
(6) Liver of lime 1 part to 20 parts of water. Immerse for 10 minutes.

Matthew Cooke was appointed Chief Executive Horticultural and Health Officer and drew up a similar set of quarantine orders which will be given under codling moth.

The Act of 1883 providing for County Boards of Horticultural Commissioners and Inspectors was soon adopted by the important agricultural counties throughout the state and many of these Boards at once formulated County Quarantine Ordinances prohibiting or regulating the importation of horticultural products infested with injurious insect pests or plant diseases or any such products which were shipped from a region known to be infested with such pests or plant diseases. Thus an attempt was made to limit the distribution of phylloxera throughout the state. This attempt appears to have been at least partially effective in that, even to the present time, this insect has never gained a foothold in the counties south of the Tehachapi Pass or south of the northern boundary of the counties of San Luis Obispo, Kern and San Bernardino. When these county ordinances became void after August 8, 1915, the phylloxera, as well as other pests, was subject to the provisions of the State and County Horticultural Commissioner Acts which have often been amended since the original acts of 1883. The most recent regulation is " An Act providing for the protection of vineyards of the state against phylloxera by regulating the transportations within the state of grapevines or parts thereof for the use of fuel " approved May 16, 1919.

In 1884 J. A. Bauer invented a remedy for phylloxera consisting of finely divided mercury introduced into the soil around the grape roots to prevent the access of the insect. This remedy was investigated by E. W. Hilgard [100] who could attribute no real value to it and it soon disappeared. Charcoal and lime had also been suggested as remedies at various times previous to this.

Although the phylloxera has spread to all the older grape-growing sections north of the Tehachapi, it does not now exist in many of the most important grape-growing sections. The use of resistant

[100] Calif. Agr. Expt. Sta., *Bul. 18* (1884); *ibid.*, *Bul. 48* (1885); *ibid.*, *Rept. 1883–84 and 1884–85*, pp. 181–204 (1886); *ibid.*, *Rept. 1885–86*, pp. 185–186 (1886).

rootstocks has occupied the attention of the viticulturists of the University of California for many years and a number of publications [101] have been issued on the subject. The older vineyards in the infested areas have been largely reconstituted on phylloxera-resistant rootstocks, so that we find by recent (1926) figures furnished upon request by the County Horticultural Commissioners, that in Sonoma, Napa, and Santa Clara counties from 85 to 95 per cent of all the vines are on resistant roots; in Solano, Contra Costa, and Alameda counties from 50 to 60 per cent; Mendocino and Fresno about 15 per cent; Sacramento, [102] San Joaquin, and Lake from 5 to 9 per cent, while the remainder have less than 1 per cent. The reason for the small percentage on resistant rootstocks is undoubtedly explained by the fact that most of the new plantings have been made on new soil and in districts not yet infested with phylloxera, although this is not always the case, as will be seen from the following letter received from H. P. Stabler, for over thirty years County Horticultural Commissioner of Sutter County, under date of September 11, 1926: "In regard to the percentage of vines grafted on resistant stocks in Sutter County, I would say the acreage is nil. Some years ago when Prof. Bioletti made a talk here on the advantage of going into resistant stocks to prevent damage from phylloxera, I became very enthusiastic and secured all the resistant wood available for distribution at Davis. But, to my utter surprise and humiliation, grape growers in the county looked at the matter with supreme indifference. Even now there are not more than three or four growers in the county, to my knowledge, who have any faith in resistant roots. In the meantime, phylloxera has destroyed over a thousand acres of vineyards and it is possible to find the pest in almost any vineyard in the county when an examination is made. The result will be that the vines will go within the next few years, but on account of the low price of Thompson Seedless, the prevailing variety grown here, growers

[101] "Between 1876 and 1898 the California Agricultural Experiment Station published about 21 bulletins and leaflets on phylloxera and resistant vines." Since 1898 eight bulletins and one circular have appeared, the latest being by F. T. Bioletti, F. C. H. Flossfeder, and A. E. Way, *Phylloxera resistant stocks*, Calif. Agr. Expt. Sta., Bul. 331, pp. 81–139, 11 figs. (Oct., 1921).

[102] A. E. Morrison, under date of October 13, 1926, writes: "In my belief, the percentage (on resistant stocks) is exceedingly small, in fact, I doubt if it would reach five per cent. The percentage in new plantings does not run over fifteen per cent with the exception of last year when 60,000 resistant vines were planted by one concern making a total of about 75 per cent for last year."

do not seem to be excited over the possibility of losing the vineyards. Some interplanting is already being done to walnuts, peaches and prunes."

Due to the very extensive plantings the new and clean vines are coming in contact with the infested vineyards and I believe that it will only be a matter of time, and not such a long time, either, when another outbreak of phylloxera will occur which will be more like that experienced in France and which will entirely change the present method of starting a vineyard by means of rooted cuttings. There is, however, a possibility that paradichlorobenzene or some other soil fumigant may save the situation and prevent such a catastrophe. I hope so!

The most important investigations on the life history of phylloxera in California were made by W. M. Davidson and R. L. Nougaret of the Bureau of Entomology, United States Department of Agriculture, the results of which were published in 1921.[103]

A study of phylloxera infestation in California as related to types of soils was published by R. L. Nougaret and M. H. Lapham in 1928 [104] and who summarized their findings for the vineyard district of Fresno and Tulare counties as follows:

That the sandy loams and soils of heavier texture of the Madera and San Joaquin series are favorable to general phylloxera infestation, and that areas of widespread and long-standing infestation occur.

That the adobe soils of the Porterville series, which are of heavy texture and of compact structure, are favorable to widespread infestation, and that areas of general infestation occur within the limits of this survey.

That the sandy loams of the Hanford and Foster series are less favorable to extensive infestation, but that areas of local infestation occur.

That the Madera and Oakley sands and the Fresno sand and Fresno sandy loams are, so far as determined, free from phylloxera infestation, and that these soils are not favorable to infestation if not practically immune.

That the lighter-textured sandy types of the Hanford series of soils, which are of only local occurrence and importance, are free from phylloxera and probably not favorable to infestation.

That the fine sandy loam and heavier types of the Fresno series are probably susceptible to local infestation, but are of limited extent and importance, and so far as determined no areas of infestation occur.

That the loam types of the associated and related Hanford, Foster, and

[103] *The grape Phylloxera in California*, U. S. Dept. Agr., Bur. Entom., Bul. no. 903 (Prof. paper) 128 pp., 10 figs., 11 pls. (Apr. 22, 1921).

[104] U. S. Dept. Agr., *Tech. Bul. 20*, 38 pp., 6 figs., 1 pl., 1 col. map (February, 1928).

Chino series, which are of minor importance in the viticultural industry, are, so far as observed, free from phylloxera-infested vineyards, but that these soils are probably not immune to infestation if it is once introduced.

Late in 1928 an infestation of grape phylloxera was discovered in a vineyard near San Gabriel, Los Angeles County, where it appears to have existed for several years. Inspections of surrounding vineyards are being made to determine the possible extent of spread and steps for control or eradication.[105]

APHIDIDÆ (Family). Aphis, Aphids.

The woolly apple aphis, *Eriosoma lanigera* (Hausm.), was introduced into California, probably on the first shipment of apple trees from Oregon in 1853. It did not attract attention, however, until about 1865 and became known as a serious pest in 1870 when resistant roots, as used in Europe, were advocated. C. H. Dwinelle definitely reported the presence of the insect in California in 1882 and again advocated the search for a resistant rootstock. He also recommended, for the infested trees, a spray of hot tobacco decoction.[106] Carbon disulfide was suggested for the control of the root-infesting forms about this time. In 1886 W. G. Klee, College of Agriculture, University of California, published a bulletin on the woolly aphis and its repression [107] in which he advocated gas lime for the soil, natural enemies, chiefly ladybirds, resistant rootstocks, and sprays of tobacco decoction (1 gallon of water to a half pound of tobacco, steeped together), and a half pound of whale oil soap applied twice at 130° F.

The pear root aphis, *Eriosoma languinosa* (Hartig),[108] was long thought to be the woolly apple aphis until determined as *Eriosoma pyri* Baker in 1916 and since proved to be identical with the European species. In some localities in California it has as an alternate host, the elm.

[105] Ryan, H. J., Calif. State Dept. Agr., *Mthly. Bul.*, vol. 17, p. 623 (1928).

[106] Calif. Board of State Hort., *First Ann. Rept.*, pp. 18–19 (1882).

[107] Calif. Agr. Expt. Sta., *Bul. 55* (1886).

[108] Weldon, G. P., *The woolly aphis as a pear pest*, Calif. State Hort. Com. Mthly. Bul., vol. 4, pp. 441–444, figs. 94, 95 (1915).

Baker, A. C., *Identity of Eriosoma pyri*, Jour. Agr. Research, vol. 5, pp. 1115–1119, 1 fig. (1916).

Baker, A. C., and Davidson, W. M., *The woolly pear aphis*, *ibid.*, vol. 6, pp. 351–360, 1 fig. (1916); vol. 10, pp. 65–74, 1 fig., pls. 9, 10 (1917).

Davidson, W. M., *The pear woolly aphis*, Calif. State Hort. Comm., Mthly. Bul., vol. 6, pp. 390–396, figs. 130, 131 (1917).

The cabbage aphis, *Brevicoryne brassicæ* (Linn.), may have been indigenous on the mustard and other cruciferous plants of the state, but was first reported on cabbage at Bodega, not far from the Russian settlement at Fort Ross, in 1876.[109]

The erroneous idea of biological control, as formerly held by many farmers and which is still held by some, is well illustrated in an early report on the control of the cabbage aphis by Felix Gillet, member of the State Board of Horticultural Commissioners and a member of the Committee on Codling Moth. He says:[110]

Here is a very good illustration of the services rendered to us by some of these parasites or predacious insects. The cabbage lice, you are well aware, are very troublesome insects, and which on certain years spread out so fast and thick that it is almost impossible to grow any cabbage heads. This very summer, these scourges of the king of the cruciferæ, made suddenly their appearance in immense numbers, all over the State. Of course I had my share of them, though I did not care, being prepared for them. I immediately hunted up the little coccinella or lady-bird, which is very common in all gardens; to that effect I took along with me a little steel pen box with a hole big enough to slip in the little beetle. Then, after having captured a certain number of the beetles, I carried them to my cabbage and rutabaga patch, and let them loose among the lice. They literally cleaned them out, no matter how fast the latter multiplied. The lady-bird's larvæ also fed on the lice, and whenever I found any, I carried them to the cabbage patch.

In 1872, when the cabbage lice were a great deal worse than this year, I paid boys fifty cents for a hundred of those lady-birds, through which I got rid of all the lice that had spread all over the cabbages, after I had tried all kinds of washes, soap suds, ashes, lime, etc. It is a simple and rational remedy, and a cheap one, too. The reason why the lady-birds have to be carried from other parts of the garden to the very spot where cabbages and rutabagas have been planted, is that like all Coleoptera, they fly with some difficulty, usually a very small distance at one time; and it might take them the whole summer before traveling from one end of the garden to the other. The shortest way, for the lice multiply very fast, is therefore to hunt up the lady-bird all over the place and carry it where its services are so much needed.

The strawberry aphis, *Myzus fragæfolii* Ckll., was reported in the state in 1880 [111] although it was not described by Cockerell until 1901.

The mealy plum aphis, *Hyalopterus arundinis* (Fabr.), was reported from Los Angeles in 1881.[112]

[109] *Pacific Rural Press*, vol. 12, p. 160 (Sept. 2, 1876).
[110] Board of State Hort. Commrs. of Calif., *First Rept.*, pp. 32–33 (1882).
[111] *Pacific Rural Press*, vol. 19, p. 332 (May 15, 1880).
[112] Chapin, S. F., State Bd. Hort. of Calif., *Bien. Rept.*, *Bul. 1*, p. 20 (1884).

The hop aphis, *Phorodon humuli* Schrank, did not appear on the Pacific Coast until 1890, when it became general and troublesome over the whole hop-growing area from California into British Columbia.[113]

The black peach aphis, *Aphis persicæ-niger* Smith, was first noticed in California during 1910 when it became quite abundant on peach trees in southern California. It has since been found throughout much of the state.

COCCIDÆ (Family). Scale Insects.

The cottony cushion scale, *Icerya purchasi* Maskell (Fig. 52). While the vine and fruit growers of northern California were struggling with the grape phylloxera, the codling moth and the San José scale, the citrus orchardists in the south were having troubles of their own in the form of the cottony cushion scale, *Icerya purchasi* Maskell, which went under such other appellations as the Australian blight, Australian bug, white scale, and fluted scale. The introduction, distribution, destruction and natural control of this pest is one of the most interesting chapters in the history of entomology. This coccid was first observed in the nursery of George Gordon at Menlo Park, California, and reported in the following manner:

At the regular meeting of the California Academy of Sciences at San Francisco on July 1, 1872, "Mr. John Hewston, Jr., exhibited some limbs of a species of Australian acacia, from San Mateo (Menlo Park), which were infested by a species of coccus, and stated that the insect had not only been detected in its depredations upon said tree, but also upon the orange trees." [114] No further comments were made at this meeting, but at a meeting on September 16, 1872, R. H. Stretch gave an extended account of the new scale bark-louse taken in the nursery of Gordon at Menlo Park on *Acacia latifolia* and thought to have been introduced from Australia about three years prior (1869). He described the adult females, eggs and young, giving the species the common name, "ribbed scale-bark louse." He also stated that specimens

[113] Clarke, W. T., *The hop aphis*, Calif. Agr. Expt. Sta., Bul. 160, 13 pp., 7 figs. (1904).

Parker, W. B., *The hop aphis in the Pacific Region*, U. S. Dept. Agr., Bur. Entom., Bul. 11, p. 1 (1913).

[114] Calif. Acad. Sci., *Proc.*, vol. 4, pp. 243–244 (1873). It has often been stated that Stretch made this report in 1868, which is an error!

were sent to C. V. Riley at Missouri, who informed him that this coccid was unknown in the Eastern States and that it agreed well with the *Dorthesia* of Australia.[115] Thus C. V. Riley first took notice of it in California in 1872. In that year the Rural Californian had advocated washing the scale-infested orange trees at Los Angeles with Peruvian guano and soap suds which was another form of potash and soap. It was introduced on lemon trees from the nursery at Menlo Park into southern California prior to 1876 and its spread and increase in the orange and lemon orchards in Los Angeles and neighboring counties was phenomenal and in that year it was also firmly established in Ventura County.

In 1877 it was recorded as a very serious pest of acacia trees in Marin County.[116] By 1882 it became so important as to cause the appointment of a special committee by the Board of State Horticultural Commissioners [117] to consider means of destroying and preventing its spread. By 1883 it was doing great damage throughout the citrus areas of southern California. Many of the lye, whale oil soap, and other washes, being tried in the north for the control of the San José scale, were also recommended for the cottony cushion scale in the south. In the same year S. F. Chapin,[118] a member of the State Board of Horticulture, experimented with twenty-five different combinations of the insecticides, then available, including lye, whale oil soap, kerosene butter, kerosene emulsion, Paris green, bitter aloes, sal soda, turpentine, turpentine emulsion, lime water, pyroligneous acid, and pyrethrum for the control of this serious pest.

C. V. Riley published an extended article on the scale in 1886 in which he described in detail the introduction, distribution, food plants, life history, stages, natural enemies and remedies [119] (Fig. 52).

In the same year also Albert Kœbele first advocated the use of the resin wash for its control. This spray was later perfected by D. W. Coquillett in 1889 and was used as late as 1914 in the citrus nurseries of the state as a mild spray for scale insects on young trees.

[115] *Ibid.*, vol. 4, pp. 262–265 (1873).
[116] *Pacific Rural Press*, vol. 13, p. 105 (Feb. 17, 1877).
[117] Calif. State Bd. Hort., *First Rept.*, p. 48 (1882).
[118] *Ibid.*, *Ann. Rept.*, pp. 23–27 (1883).
[119] U. S. Dept. Agr., *Rept.*, 1886, pp. 466–492, pls. i–v (1887); *ibid.*, Div. Entom., *Bul. 15*, 40 pp. (1887).
Cottony cushion scale: important discussion of its identity, Pacific Rural Press, vol. 34, pp. 238–239 (Sept. 24, 1887).

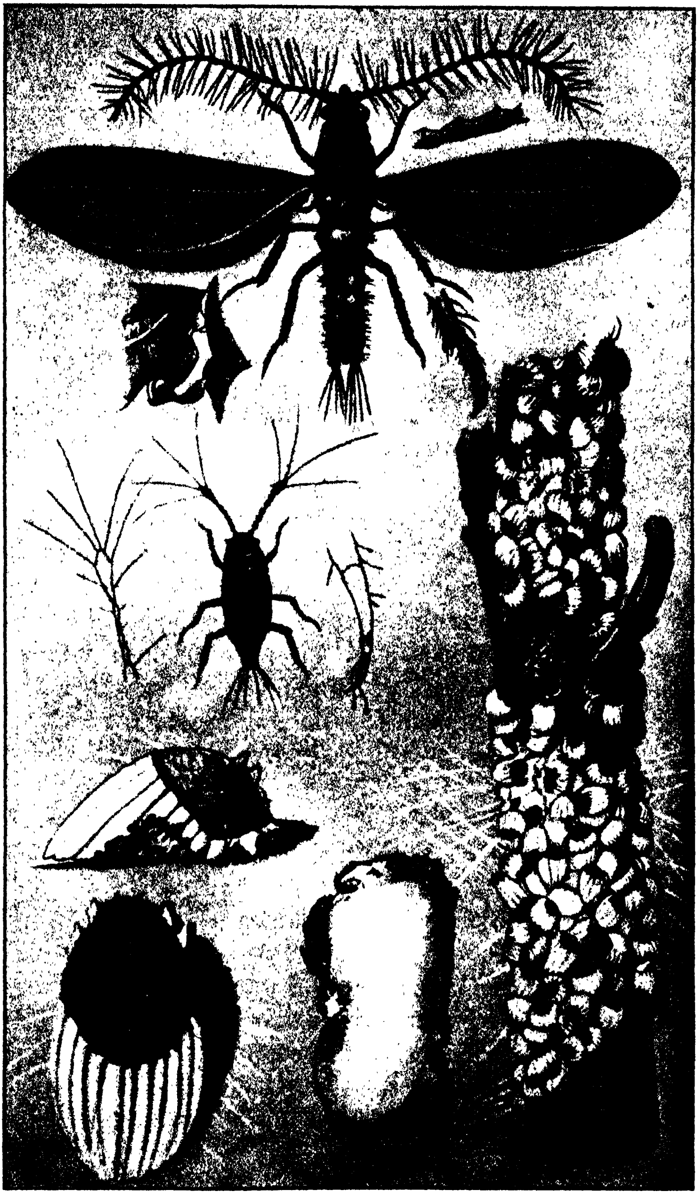

FIG. 52.—An excellent early illustration of the various stages and certain characters of the cottony cushion scale, *Icerya purchasi* Maskell, published by C. V. Riley in the Report of the Department of Agriculture for 1886.

D. W. Coquillett, an agent of the Bureau of Entomology, U. S. Department of Agriculture, stationed in southern California, first began experimenting with HCN as a means of destroying scale insects on citrus trees in 1886.[120] In 1887 F. W. Morse was delegated by E. W. Hilgard of the University of California to test out various gases for the control of scale insects on citrus trees. He experimented with eight different gases including: chlorine, CS_2, sulfureted hydrogen, ammonia, carbon monoxide, oxalic acid, carbolic acid, and HCN.[121] HCN was the only one found satisfactory and for it he worked out a schedule of doses for different size trees together with the methods of operation, time of treatment, and noted injuries to the foliage. The HCN was generated by using cyanide of potassium, bicarbonate of soda, and sulfuric acid.

In the same year D. W. Coquillett, who was working with Alexander Craw and J. W. Wolfskill, announced success in killing the cottony cushion scale with HCN and Coquillett also made his Report on the Gas Treatment for Scale Insects.[122] In 1888 he presented a paper entitled, Improved Methods in Chemical Fumigation, before the Ninth State Convention of Fruit Growers, at Santa Barbara on April 10. In the new method the HCN gas was generated from pot-cyanide and sulfuric acid, which was a noticeable advance over the old method. Morse in 1888 conducted further experiments on the cause and avoidance of injury to foliage in the HCN treatment of trees.[123] In this he showed that the influence of ammonia as the chief cause of injury and also that of temperature.

Further investigations with insecticides for the control of the cottony cushion scale were cut short by the introduction of natural enemies, which accomplished control in a few years.

The Board of State Horticultural Commissioners first considered the propagation of beneficial insects in 1881,[124] but went no further than to discuss the matter. Alexander Craw suggested the use of natural enemies as a means of control for the cottony cushion scale

[120] *Insect Life*, vol. 3, p. 457 (1891).

[121] *The use of gases against scale insects*, Calif. Agr. Expt. Sta., Buls. 71 and 73 (1887).

[122] C. V. Riley, U. S. Dept. Agr., *Ann. Rept. Commr.*, 1887, pp. 123–142 (1888).

[123] Calif. Agr. Expt. Sta., *Bul. 79* (1888).

[124] Calif. State Bd. Hort., *Ann. Rept.*, 1889, p. 260 (1890).

Rice, George, *The rise and downfall of the cottony cushion scale*, *ibid.*, Rept., 1890, pp. 53–57 (1890).

in 1887 and advocated sending D. W. Coquillett to Australia for the purpose. After a considerable amount of negotiations, C. V. Riley finally made arrangements to send Albert Kœbele to Australia and he accordingly sailed from San Francisco on August 25, 1888.

The dipterous parasite of the cottony cushion scale, *Cryptochætum iceryæ* (Williston) (*Lestophonus*), was first brought to the attention of the entomologists of the United States through correspondence with Frazer S. Crawford, of Adelaide, South Australia, who later sent specimens which were described by S. W. Williston.[125]

It was for this insect that Kœbele was sent to Australia. Therefore, he devoted most of his attention to it on his first trip to Australia in 1888–1889. As a result he sent over quantities of the parasite in all stages, the total number estimated at 12,000. These were carefully cared for by Coquillett and the progeny distributed throughout central and southern California. The parasite increased abundantly and in many localities proved as effective and in a few places even more efficient in destroying the cottony cushion scale than the vedalia.

During his investigations in Australia Kœbele also discovered the vedalia, then an unknown enemy of the cottony cushion scale and begun sending it to California. On November 30, 1888, the first lot of vedalia, *Rodolia cardinalis* (Muls.), consisting of 28 specimens, shipped by Kœbele from Australia, arrived in California. The second lot, consisting of 44 adults, arrived on December 29 and the third lot of 57 adults on January 24, 1889. In all there were 129 specimens.[126] These were taken care of by D. W. Coquillett who reared and distributed 10,555 specimens by June 12, 1889. Two other shipments were received from Kœbele: one on February 21, consisting of 35 specimens, and the last on March 20, 1889, numbering 350 specimens. These were colonized directly in the infested orange orchards. The results were phenomenal and so effectively did this beetle destroy the scale that in less than a year all fear was banished and by 1892 the orchards were practically clean (see vedalia, p. 298). Kœbele's ladybird, *Novius kœbelei* (Olliff), was introduced in 1892 and also proved to be an efficient

125 *Insect Life*, vol. 1, pp. 21–22, 1 fig. (July, 1888).
126 *Insect Life*, vol. 2, pp. 73–74 (1889).
Kœbele, A., *Rept. of a trip to Australia to investigate the natural enemies of the cottony cushion scale*, U. S. Dept. Agr., Div. Entom., Bul. 21, 32 pp., 16 figs. (1890).

predator. Both of these beetles still persist in California and continue to wage war on the remnants of the vanquished cottony cushion scale wherever it may show up (also see Kœbele's ladybird, p. 302). In cases of new infestations of the scale the beetles are either collected in the orchards or are secured from a supply kept on hand for such purposes by the state insectary.

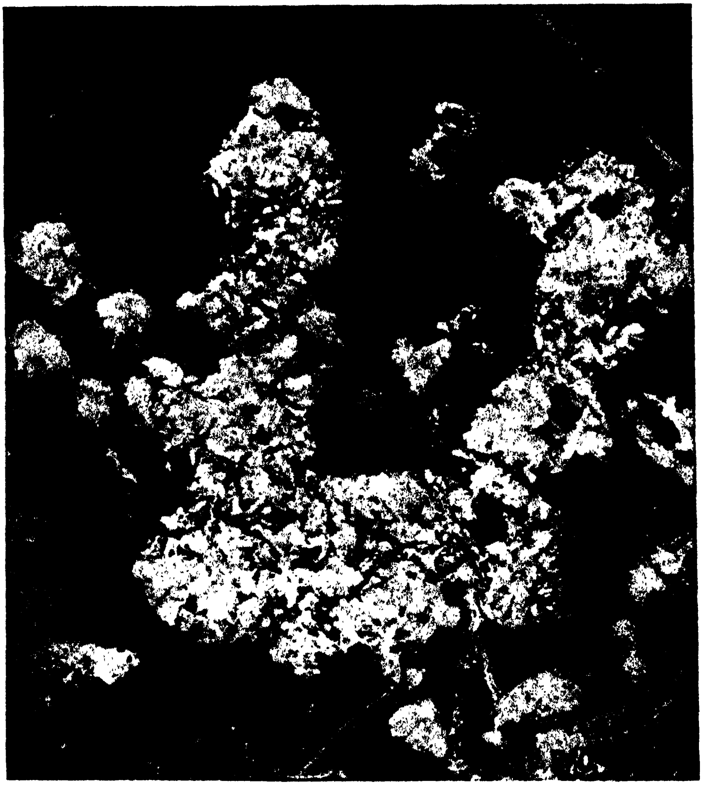

FIG. 53.—The cottony cochineal scale, *Dactylopius tomentosus* (Lamarck), on opuntia cactus. This native insect yields a fair dye which was early used by the Indians. The commercial cochineal, *D. coccus* Costa, is indigenous to Mexico and a very close relative of the above. The production of cochineal dye was advocated in California as early as 1871, but never assumed commercial importance.

This simple and effective campaign was given wide publicity and similar experiences have been repeated with the same host and natural enemies in many parts of the world. It marked a new era in economic entomology, that of biological or natural control.

This new method of natural control is difficult and slow and has usually failed only where those in charge have expected too easy and quick returns, but where sufficient capital and thoroughly competent men have been provided, it has almost always brought either complete or partial subjugation of the pests.

In 1914–1915 the cottony cushion scale was found in destructive numbers on certain varieties of pears, particularly the Winter Nelis near the city of San José, California. The vedalia was repeatedly secured and liberated in the infested orchards without avail. Branigan,[127] an assistant of the state insectary, looked into the matter and came to the conclusion that the arsenate of lead spray, applied to the pears for the control of the codling moth, adhered in sufficient quantities to the scale insects to poison and kill the predators. Coccids reared on pears in confinement were readily destroyed by the vedalia. The infestations were eventually cleaned up by knocking the scales off by applying water under 300 to 400 pounds pressure with spray rods and guns and the use of oil sprays, during the dormant period of the trees.

FIG. 54.—The red date scale, *Phœnicococcus marlatti* Ckll., also sometimes known as the Marlatt scale, was introduced into the Southwest in 1890. Because it is so completely hidden in the unfolding leaves, it is often entirely overlooked. (The specimen represented was collected in the Imperial Valley, October 18, 1918.)

Cochineal was a valuable dye product in the early development of California. The native cochineal, *Dactylopius confusus* (Ckll.) and *D. tomentosus* (Lamarck) (Fig. 53), never became a commercial

[127] Branigan, E. J., Calif. Hort. Com., *Mthly. Bul.*, vol. 4, pp. 107–108 (1915).

item, although attention was called to its good qualities in 1871. It was further stated at this time that good cochineal was worth two dollars and a half a pound, and that one plant should yield twenty pounds annually.[128] The two species in question have generally gone under the scientific name of the first. They occur often abundantly on the native opuntia cacti occurring in southern California, Arizona and the former also in Mexico, New Mexico, Colorado, and Montana.

The European elm scale, *Gossyparia spuria* (Modeer), was discovered at Palo Alto in 1893 by E. M. Ehrhorn.[129] Since that time it is known to have spread to other parts of Santa Clara County and to San Joaquin, Stanislaus, Yolo, Colusa, Mendocino, and Marin counties. It is a great nuisance in cities because of the large amounts of honeydew produced and which drops on the houses, sidewalks, and parked automobiles. Control measures consist in the use of dormant miscible oils and distillate emulsions.

The red date scale,[130] *Phœnicococcus marlatti* Cockerell,[131] (Fig. 54), was originally described as a new genus and new species by Cockerell [132] in 1899 from specimens collected August 7, 1890, on young date palms imported from Cairo, Egypt, and Algeria into the United States in 1889 and held in the experimental grounds of the U. S. Department of Agriculture at Washington, D. C., and was introduced into California in 1890. The history of the

[128] *Pacific Rural Press*, vol. 2, p. 275 (May 6, 1871).

[129] State Board of Hort., *Ann. Rept. for 1893-94*, pp. 90–91 (1904).

[130] This species has also been known in the past as the Marlatt scale.

[131] Newstead, R., *The date palm scale*, Agr. News, Barbados, vol. 5, no. 111, p. 234 (1906); *Quart. Jour. Liverpool Univ.*, vol. 1, p. 70 (1906) (*Sphærococcus draperi* Newst.); *Bull. Entom. Research*, vol. 2, p. 104 (1911).

Popenoe, P. B., *Date growing in California*, Calif. State Hort. Com., Mthly. Bul., vol. 1, p. 871 (1912).

Date growing (*Altadena, Calif., West India Gardens, 1913*), pp. 151–158.

Wilsie, W. E., *The date palm scales and their control*, Calif. State Hort. Com., Mthly. Bul., vol. 2, pp. 538–539 (1913).

Essig, E. O., *Injurious and beneficial insects of California*, p. 94, fig. 73 (1913); ed. 2, pp. 123–124, fig. 105 (1915); *Insects of Western North America*, pp. 276–277 (1926).

Cook, A. J., *The date scales*, Calif. State Hort. Com., Mthly. Bul., vol. 3, pp. 440–441, fig. 106 (1914).

Buxton, P. A., *Insect pests of dates in Mesopotamia*, Bul. Entom. Research, vol. 11, pp. 298–299 (1920–1921).

Borden, A. D., *A biological study of the red date-palm scale, Phœnicococcus marlatti*, Jour. Agr. Research, vol. 21, pp. 659–668, pls. 127–130 (1921).

Morrison, H., *Red date-palm scale, Phœnicococcus marlatti:* a technical description, *ibid.*, vol. 21, pp. 669–676, fig. 1, pls. 131–134 (1921). Bibliography.

[132] Cockerell, T. D. A., *Proc. Acad. Nat. Sci.*, Philadelphia, p. 262 (1899).

treatment, shipment, and establishment of these infested palms is given in connection with the parlatoria date scale, *Parlatoria blanchardi* (Targ.), described elsewhere in this work. Inasmuch as this scale is usually concealed in the unfolding leaves and fruit stems at the bases of the branches and among the superficial roots, it was never as readily detected as the date palm scale, and therefore much of the history of its spread in the Southwest must be gained from the latter. It was no doubt established in Arizona and California in 1890 and reëstablished with other importations of date palm offshoots. Up to 1915 approximately 35,000 offshoots were imported into California and Arizona, of which it is estimated that 20,000 were infested with scales. From 1920–1922, inclusive, an additional 12,000 were imported and held for observation in quarantine nurseries.

In 1921 Borden and Morrison [133] each made an important contribution in studies of this obscure coccid. The control measures for it consisted chiefly in the application of phenolic-soap emulsions.

In 1920 Mackie [134] tested vacuum fumigation for the control of this pest on young offshoots and concluded with the note that "Growers report complete destruction of the scale and no injury to the offshoots."

The eradication campaign in connection with the more destructive date palm scale may also serve to eradicate or to very greatly reduce this insect also.

The present known distribution of this scale, outside of California and Arizona, is as follows: Africa-Egypt, Algeria, Tunis, Tripoli, and Sahara; Europe-Italy; Asia-Palestine and Mesopotamia.

The citrus mealybug, *Pseudococcus citri* (Risso) (Fig. 55),[135] is a European insect originally described from orange in Italy by

[133] *Op. cit.*

[134] Mackie, D. B., Calif. State Dept. Agr., *Mthly. Bul.*, vol. 9, pp. 432–433 (1920).

[135] Comstock, J. H., *The destructive mealy bug*, Dactylopius destructor *Comst.*, Rept. Commr. Agr., 1880, pp. 342–343, pl. xi, fig. 3, pl. xxii, fig. 2 (1881).

Essig, E. O., *The citrus mealybug*, P. C. Jour. Entom., vol. 2, pp. 289–320, figs. 111–119 (1910). Bibliography.

The mealybugs of California, Calif. State Hort. Com., Mthly. Bul., vol. 3, pp. 97–143 (111–116), figs. 21, 27–31 (1914).

Injurious and beneficial insects of Calif., *ibid.*, pp. 99–104, figs. 78–84 (1913); ed. 2, pp. 126–129, fig. 108 (1915); *Insects of Western North America*, pp. 280–281, figs. 164–166 (1926).

Smith, P. E., *Specific characters used in the genus* Pseudococcus, Ann. Entom.

J. A. Risso in 1813.[136] It is a tropical and semitropical species which occurs in many parts of the world and has been widely distributed on ornamental nursery stock and has extended its range into the temperate region as a pest in greenhouses.

In 1903, Fernald [137] gave 44 separate citations to literature, listed it on some twelve host plants, and gave the world distribution as follows: Europe, Sandwich Islands, Mauritius, Brazil, Jamaica, Canada and the United States (Mass., N. Y., N. J., La., Fla.). Since then this insect has been noted on a great many hosts and has been reported from the following places and probably occurs in many others.

Europe—Caucasus, Crimea, England, France, Germany, Hungary, Italy, Portugal, Spain, Sweden.

Asia—Borneo, Ceylon, Dutch East Indies, French Indo China, Formosa, India, Japan, Java, Mauritius, Mesopotamia, Palestine, Philippine Islands, Seychelles Islands, Tobago, Transcaucasia.

Africa—Algiers, Belgian Congo, British East Africa, Egypt, German East Africa, Kenya Colony, Morocco, Rhodesia, South Africa, Southern Nigeria, Uganda, Zanzibar.

South America—Brazil, British Guiana, Chile, Paraguay, Peru, Uruguay.

Central America—Guatemala.

North America—Barbados, Bermuda, Canada, Jamaica, Mexico, Porto Rico, Santo Domingo, United States, West Indies.

General—Guam, Hawaii, Samoa, San Thome, Trinidad.

This mealybug was probably introduced into North America at a very early date. In 1841 Harris [138] referred to the "mealy bug of our greenhouses" as *Coccus adonidum*. While this scientific name usually referred to the **long-tailed mealybug,** *Pseudococcus*

Soc. Am., vol. 4, pp. 309–327 (1911); *P. C. Jour. Entom. and Zoöl.*, vol. 5, pp. 69–84, figs. 1–17 (1913).

Speare, A. T., *Natural control of the citrus mealybug in Florida*, U. S. Dept. Agr., Farmers' Bul., 1117, 18 pp., 2 figs. (1922).

Clausen, C. P., *Mealy bugs of citrus trees*, Calif. Agr. Exp. Sta., Bul. 258, pp. 21–26, figs. 1, 2 (1915).

Woglum, R. S., and Neuls, J. D., *The common mealybug and its control in California*, U. S. Dept. Agr., Farmers' Bul. 862, 16 pp., 5 figs. (1917).

Ferris, G. F., *Methods for the study of mealy-bugs*, Jour. Econ. Entom., vol. 10, pp. 321–324 (1917).

The California species of mealy bugs, Leland Stanford Jr., Univ. Pub., Univ. Ser., pp. 39–40, pl. 1, figs. 7, 9 (1918).

Borden, A. D., *Control of the common mealbug on citrus in California*, U. S. Dept. Agr., Farmers' Bul. 1309, 10 pp., 6 figs. (1923).

[136] Risso, J. A., *Essai*, Hist. Nat. des Oranges (1813).

[137] Fernald, M. E., *A catalogue of the Coccidæ of the world* (Amherst, Mass., Carpenter and Morehouse, 1903), pp. 99–100.

[138] Harris, T. W., *A treatise on some of the insects of New England which are injurious to vegetation*, ed. 2 (Boston, White and Potter, 1852), p. 218; Flint ed. (Boston, Crosby and Nichols, 1862), p. 250 (1862).

longispinus (Targ.), it may have applied to the citrus mealybug in this case. Anyway it indicated an early knowledge of mealybugs in the history of economic entomology in America.

Ashmead [139] observed it attacking orange trees in Florida and described it as the leaf-scaled coccus, *Lecanium phyllococcus,* in

FIG. 55.—The citrus mealybug, *Pseudococcus citri* (Risso), although once an important economic species in the citrus orchards of southern California, has in large measure given way to the hardier and more aggressive citrophilus mealybug, *Pseudococcus gahani* Green. It is a common greenhouse pest throughout the country. (Photograph taken in 1912.)

1879. Comstock [140] described the species as *Dactylopius destructor* in 1881 from specimens taken in the department greenhouses at Washington, D. C., in 1880. He states: "The name *destructor* is, however, proposed for this insect from the damage done by it to orange trees in Florida, especially at Jacksonville and Micanopy, where it is the most serious insect pest of orange."

The insect generally occurs throughout the United States in

[139] Ashmead, W. H., *Injurious and beneficial insects found on the orange trees of Florida*, Canadian Entom., vol. 11, p. 160 (1879).
[140] Comstock, J. H., *op. cit.*, p. 343 (1881).

greenhouses and also out of doors in the southern states and in southern California.

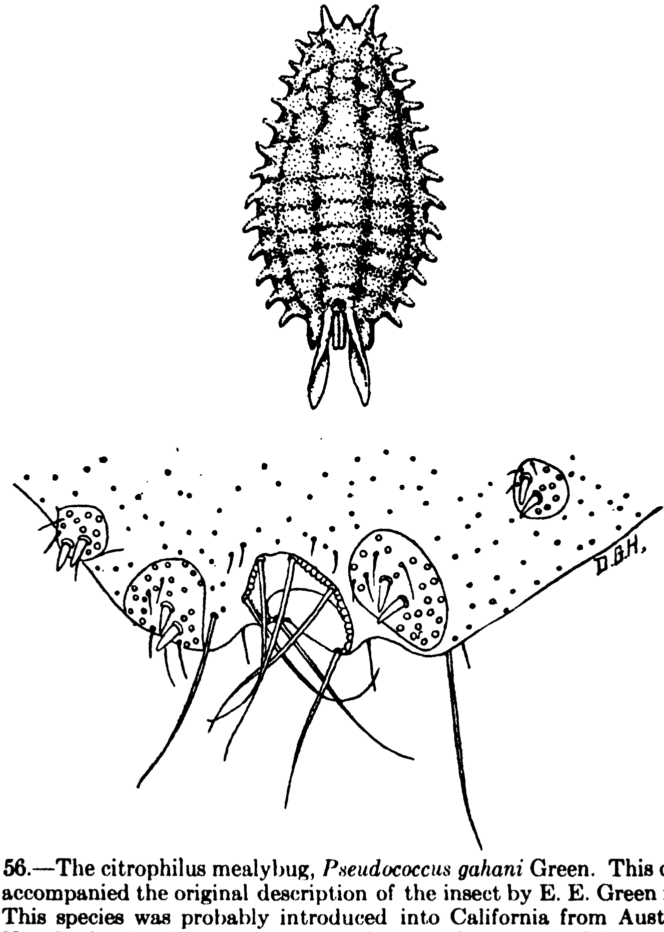

FIG. 56.—The citrophilus mealybug, *Pseudococcus gahani* Green. This drawing accompanied the original description of the insect by E. E. Green in 1915. This species was probably introduced into California from Australia or New Zealand and has proved to be the most destructive of the mealybugs in this state. Adult female × 13, pygidium of same × 135.

In California it was no doubt early introduced on ornamental greenhouse plants where it may still often be found plentiful. In the citrus orchards it was first noted as a pest in Ventura and San Diego counties about 1897 and must have appeared in many other localities at approximately the same time. Its range was along the coastal region of the citrus belt. In 1907 it attracted considerable attention and in 1909 considerable alarm was felt by many of the

citrus orchardists—so much so that at a meeting of the Claremont Pomological Club, Claremont, Calif., January 18, 1909, called by A. J. Cook, the citrus mealybug was the special topic of discussion and the results were published [141] and widely distributed throughout the south. This and other meetings created a great deal of interest in the mealybug situation, which was serious in certain areas, particularly at Santa Paula, Ventura County; Whittier, Los Angeles County, and at Bonita, San Diego County. P. E. Smith, County Horticultural Commissioner of Ventura County, did a great deal of experimental work with HCN fumigation in 1909, which was followed at all of the important centers of infestation. This work was continued by the writer in Ventura County in 1910–1911 and many kinds of sprays were also experimented with. As a result of the combined efforts of many investigators in a combined program of fumigation, spraying, and the use of natural enemies, the mealybug was soon under commercial control.

Beginning with the appearance of the citrophilus mealybug, *Pseudococcus gahani* Green, in southern California in 1913 and the subsequent rapid spread of this species in the areas originally occupied by the citrus mealybug, the latter gradually gave way to this new and apparently more vigorous species until at the present time the citrus mealybug is not of common occurrence as a pest. In the San Francisco Bay region the citrus mealybug has never been able to successfully maintain itself out of doors, whereas the citrophilus mealybug is most hardy throughout the region and a pest of major importance.

The citrophilus mealybug, *Pseudococcus gahani* Green,[142] (Fig. 56) was described by E. E. Green in 1915 from specimens collected on *Ribes sanguinea* in London on March 20, 1915, by C. J. Gahan, for whom the species was named. The fact that two females were collected on a plant in the garden showed the ability of the insect to winter out of doors in London, an indication of the hardiness of the species.

[141] *Mealybug and fumigation*, Claremont Pomological Club, 23 pp., 4 figs. (Jan. 18, 1909).

[142] Green, E. E., *Entom. Mthly. Mag.*, vol. 51, pp. 179–180, pl. 16, figs. 4–5 (1915). Original description.

Essig, E. O., *Pacific Fruit World*, vol. 39, pp. 1–3 (Jan. 24, 1914); Calif. State Hort. Com., *Mthly. Bul.*, vol. 3, pp. 85, 111, 159 (1914) *P. bakeri* Essig.

The Ontario mealybug, Pseudococcus *sp.*, *ibid.*, vol. 4, pp. 343–344, fig. 72 (1915); vol. 5, pp. 376 (1916).

This very injurious mealybug first came under observation in an orange orchard at Upland, California, in December, 1913, when it was reported by county horticultural commissioner S. A. Pease. It was first thought to be *Pseudococcus maritimus* (Ehrh.) (*P. bakeri* Essig), but was determined as a new species by C. P. Clausen in 1915 who named it the citrophilus mealybug, *P. citrophilus*.[143] At this time it occupied an area at Upland of about ten acres and was recorded from twenty-three different host plants. In 1918 the infested area at Upland was increased to 600 acres and in 1922 to over 1000 acres. In the latter year it also was found in the counties of Riverside, Los Angeles, and Orange. By 1924 it had generally spread throughout the southern citrus areas, but according to Armitage [144] less than 5% of the total citrus acreage was infested at that time. Since then, however, the increase has continued until this mealybug became an important insect pest in many sections and particularly in the coast counties from Santa Barbara on the north into San Diego on the south.

In the northern part of the state this insect was first noted by the writer in Oakland and Berkeley in 1915 and at Niles and the Mission San José in 1916. The next year it was found throughout the San Francisco Bay region where it has become a serious pest to flowers, ornamental and native shrubs, fruits, berries, and nursery stock in general. In parks and other public plantings it is specially injurious. On September 9, 1921, specimens were received on apple from Guerneville, Sonoma County. In 1928 it was abundant on poison hemlock at Salinas and in the fall of 1928 it was found

Insects of Western North America, pp. 282–283, figs. 167–168 (1926).

Clausen, C. P., Calif. Agr. Expt. Sta., *Bul. 258*, pp. 30–35, figs. 1b, 7, 6 (1915) *P. citrophilus*. Original description.

Ferris, G. F., *The California species of mealy bugs*, Leland Stanford Jr., Univ. Pub., Univ. Ser., pp. 40–41, pl. 1, fig. 6 (1918).

Observations on some mealy-bugs, Jour. Econ. Entom., vol. 12, pp. 292–293 (1919).

Scale insects of the Santa Cruz Peninsula, Stanford Univ. Pub., Univ. Ser. Biol. Sci., vol. 1, no. 1, p. 29 (1920).

Smith, H. S., and Armitage, H. M., *Biological control of mealybugs*, Calif. State Dept. Agr., Mthly. Bul., vol. 9, pp. 103–158, figs. 39–67 (1920).

Woglum, R. S., and Borden, A. D., *Control of the citrophilus mealybug*, U. S. Dept. Agr., Bul. 1040, Prof. paper, 20 pp., 13 figs. (April 12, 1922).

Armitage, H. M., *The citrophilus mealy bug*, Pseudococcus gahani *Green, as a major pest of citrus in southern California*, Jour. Econ. Entom., vol. 17, pp. 554–561 (1924).

Brock, A. A., *Citrophilus mealybug in California*, Calif. State Dept. Agr., Mthly. Bul., vol. 16, pp. 342–344 (1927).

Smith, H. S., and Compere, H., *Jour. Econ. Entom.*, vol. 21, pp. 664–669 (1928).

[143] Clausen, C. P., *op. cit.*

[144] Armitage, H. M., *Jour. Econ. Entom.*, vol. 17, p. 557 (1924).

infesting the fruit of pears in the Carmel Valley, Monterey County.

Although Ferris [145] cleared up the identity of this species in 1919, its origin remained a mystery. That Ferris did not suspect England of being its original home is expressed in his own words: "Here it is without much doubt an introduced species and as its original home is unknown all records of its occurrence in other lands are of importance as affording possible clues to its origin. However, I am inclined to think that it is an alien in England as well as here, for it seems doubtful that such a species would so long have remained unnoticed."

Sharing this belief H. S. Smith, who was desirous of securing natural enemies to hold the pest in check, decided to send his assistant, Harold Compere, to investigate Australia and New Zealand as possible homes of the mealybug and as a source of the hoped-for enemies. Accordingly Compere sailed for Australia in August, 1927, and was rewarded not only in finding the mealybug at Sydney, Australia, and in New Zealand, where it is thought to have been carried from Australia, but also in securing six different natural enemies at Sydney which were brought to Riverside, California, for propagation and liberation. Two of the hymenopterous parasites, the green lacewing and a diplosis fly have been colonized in the orchards and give promise of assisting in the biological control of the citrophilus mealybug, for which the mealybug destroyer, *Cryptolæmus montrousieri* Muls.,[146] is being reared at the rate of 40 to 50 millions a year.

The grape mealybug, *Pseudococcus maritimus* (Ehrhorn) (Fig. 57), was originally described by E. M. Ehrhorn [147] in 1900 from specimens taken on the roots of wild buckwheat, *Eriogonum latifolium* Sm., growing on the cliffs at Santa Cruz, California, July, 1899. No economic significance was connected with the insect until it was found infesting English walnut, apple, and pear trees in Ventura County by the writer in 1909 and described as *Pseudococcus bakeri*.[148] The mealybug found infesting citrus trees

[145] Ferris, G. F., *Jour. Econ. Entom.*, vol. 12, pp. 292–293 (1919).

[146] See the chapter on biological control for a more comprehensive discussion of the control of this and other species of mealybugs by the use of natural insect enemies.

[147] *Canadian Entom.*, vol. 32, p. 316, pl. 7, fig. 7 (1900).

[148] Essig, E. O., *A new mealybug infesting walnut, apple and pear trees*, P. C. Jour. Entom., vol. 2, pp. 339–345, figs, 126–127 (1909).

at Upland in 1913 was first thought to be this species, but was later determined as a new species which became known as the citrophilus mealybug, *Pseudococcus gahani* Green.

By 1913 [149] it was unknown as a pest outside of Ventura County, but by 1915 [150] it had been reported in many localities throughout

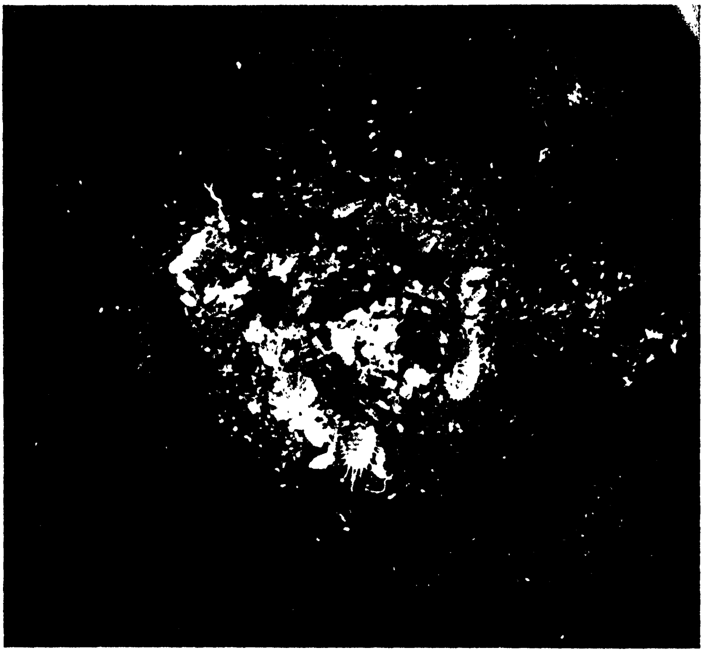

FIG. 57.—The grape mealybug, *Pseudococcus maritimus* (Ehrh.), infesting the blossom-end of a Winter Nelis pear, San José, California, 1922. It was an important pest of grapes in San Joaquin Valley in 1918. It also occurs in some states east of the Rocky Mountains. (Photograph Sept. 2, 1922.)

the state and on a number of hosts. It had already been observed on grapes in the San Joaquin Valley and by 1917 was considered to be a pest of considerable importance in the vineyards of Fresno County.[151] By 1918 it had become established in the counties of

The mealybug taken on elder, Sambucus glauca Nutt., and referred to as *P. obscurus* Essig, proved also to be the same species.

[149] Essig, E. O., *Injurious and beneficial insects of California*, p. 98, fig. 77 (1913).

[150] *Ibid.*, ed. 2, p. 126, fig. 107 (1915).

[151] Smith, H. S., *Insect parasites and predators as adjuncts in the control of mealybugs*, Calif. State Hort. Com., Mthly. Bul., vol. 6, pp. 108–114 (p. 114) (1917).

Nougaret, R. L., *Grape mealybug*, Calif. State Hort. Com., vol. 7, pp. 511–514, figs. 67–69 (1918).

Roullard, F. P., *Grape mealybug control*, Fresno Co. Farm Bureau Mthly., vol. 2, no. 3, p. 3 (March, 1919).

Fresno, Kings, Tulare, Merced, and San Joaquin. In 1920 it was observed in the vineyards at Lodi. In 1924 an insectary was established there in an experimental attempt to control this mealybug on grapes by natural enemies. This insectary is still in operation. The actual results so far accomplished are difficult to evaluate, but they are sufficiently promising to cause the continuance of the work. In 1921 it appeared in the pear orchards of Santa Clara County and caused considerable trouble, but was controlled by carbolic acid emulsion [152] and miscible oil sprays. It has since almost disappeared there. Although this particular species of mealybug was common and often abundant in the San Francisco Bay region in 1914, it gradually diminished after the appearance of the citrophilus mealybug in 1916 until at the present time (1929), it is reduced to such small numbers as to be hardly procurable.

In 1918 Ferris [153] worked up the synonymy of the species and showed that *P. obscurus* Essig, *P. bakeri* Essig and *P. omniveræ* Hollinger [154] were all synonyms of *P. maritimus* (Ehrh.). He further added New York, Missouri, and Oregon to the area of distribution. In 1919, Ferris [155] also listed this mealybug from England and Florida, and found it in Lower California the same year.[156]

In 1922, Hough [157] showed that the supposed summer form of *Trionymus trifolii* (Forbes) was *P. maritimus* (Ehrh.) and listed it in the states of Ohio and Virginia. "In the botanical greenhouse at Ohio State University it ranks second to *Pseudococcus citri* (Risso) as a mealybug pest. In this greenhouse it was found on 26 different host plants. The common name 'omnivorous mealy bug,' which was once aptly applied to this insect, is not a misnomer. It is now recorded from 80 hosts and the list is far from complete. In the Shenandoah Valley of Virginia it far outnumbers the clover root

Flebut, A. J., *The grape mealybug*, Calif. State Dept. Agr., Proc. Co. Hort. Commrs., Mthly. Bul., vol. 11, pp. 1–11 (1922).

Timberlake, P. H., and Clausen, C. P., *The parasites of* Pseudococcus maritimus *(Ehrhorn) in California*, U. C. Pub. Tech. Bul., Entom., vol. 3, pp. 223–292, 8 figs., pls. 18, 19 (1924).

[152] Essig, E. O., Calif. Agr. Exp. Sta., *Rept.*, 1921–1922, p. 87 (1922).

[153] Ferris, G. F., *The California species of mealybugs*, Leland Stanford Univ., Univ. Ser., pp. 48–49, fig. 11, pl. 2, fig. 13 (1918); *Entom. News*, vol. 29, pp. 351–352 (1918).

[154] Hollinger, A. H., *Taxonomic value of antennal segments of certain Coccidæ*, Ann. Entom. Soc. Am., vol. 10, p. 271, pl. 22, fig. 31 (1917).

[155] Ferris, G. F., *Jour. Econ. Entom.*, vol. 12, p. 293 (1919).

[156] Ferris, G. F., *Rept. upon a collection of Coccidæ from Lower California*, Stanford Univ., Univ. Ser., Biol. Sci., vol. 1, no. 2, p. 83 (1921).

[157] Hough, W. S., *Entom. News*, vol. 33, pp. 174–176 (1922).

mealy bug on the roots of clover, but in central Ohio the latter was more abundant."

It appears that this insect has had a general decline in most places in the state. Whether this is due to being crowded out by

Fig. 58.—The citricola scale, *Coccus pseudomagnoliarum* (Kuw.), a Japanese species, was discovered in southern California in 1909. After twenty years it has subsided to a place far below its initial plane of destructiveness. × 3. (Photograph taken in 1914.)

the citrophilus mealybug, in districts where this competition is possible, or by natural enemies, especially in the San Joaquin Valley, is not known at this time.

Gray citrus or citricola scale, *Coccus pseudomagnoliarum* (Kuwana) (Fig. 58), was observed for a number of years in southern

California on citrus trees before its identity was known. R. S. Woglum relates that he noted it in 1907, but considered it to be a form of the soft brown scale.

On March 26, 1909, I noted a very severe infestation of this scale in the orange orchard of W. Jones, near Claremont, California. It was so abundant upon the twigs and smaller shoots of mature orange trees that it at once attracted my attention as being different from the soft brown scale. Being then an amateur in the classifying of scale insects I recorded it under the name of *Coccus longulus* Dougl.,[158] the species it most nearly approached from the descriptions available. It did not come into prominence until 1914, when it was found to occur in a number of citrus growing districts in Los Angeles, San Bernardino, Riverside, Tulare,[159] and Fresno counties. It was limited chiefly to the warmer sections and its work was both rapid and destructive. In this same year also, Campbell made a careful study of the species and after comparing it with related forms decided it was a new species and named it *Coccus citricola*,[160] hence the origin of the common name, citricola scale. For a few years this destructive species occupied the chief interests of entomologists in the infested areas. It was found that the young began to appear in late April and continued until August; that the growth of the scales was very slow until the following spring when maturity was quickly reached and the eggs and young brought forth; that in general respects it followed the life history of the black scale, and succumbed to the same type of control, viz., spraying with oil emulsions during the months of August and September, and by fumigating with HCN during the same period.

In 1915, Quayle [161] published an extended bulletin on the insect. In addition to the counties already listed he added, Yuba, Sutter,

[158] Essig, E. O., *P. C. Jour. Entom.*, vol. 1, pp. 31–33, fig. 21 (1909).
Kell, D., *The longulus scale*, *ibid.*, vol. 4, pp. 798–800 (1912); *Proc.*, 57th Calif. State Fruit Growers' Conv., pp. 244–247 (1915).

[159] It was first noted as a pest of citrus trees in Tulare County in 1913.
Cundiff, R. P., *Fumigating in Tulare County for the soft gray scale*, Proc. 45th Calif. State Fruit Growers' Conv., pp. 314–318 (1914); *ibid.*, *47th Conv.*, pp. 248–256 (1915).
Brann, F. R., *Spray versus fumigation in the control of gray citrus scale on citrus trees in Tulare County*, Calif., State Hort. Com., Mthly. Bul., vol. 8, pp. 104–107, fig. 56 (1919).

[160] Campbell, R. E., *Entom. News*, vol. 25, pp. 222–224 (1914).

[161] Quayle, H. J., *The Citricola Scale*, Calif. Agr. Exp. Sta., Bul. 255, pp. 405–421, 7 figs. (1915).

Sacramento, and Orange.[162] He gave a complete account of the life history and control.

The exact identity of this species was discovered by C. P. Clausen; while visiting Japan in 1926 he found the scale on citrus there and thus cleared up the many conjectures as to its native home. When it was first introduced into California is not known, but it must have been from ten to twenty years prior to its discovery. The Japanese entomologist Kuwana [163] found this coccid on citrus in Tokyo and Shizuoka, Japan, in May, 1912, and described it as a new species, *Lecanium pseudomagnoliarum* in March, 1914, thus antedating Campbell's description only by two months. However it is not yet determined that Japan is the native home of the insect.

FIG. 59.—The barnacle scale, *Ceroplastes cirripediformis* Comst., is an insect common in the southern states and usually of little consequence, which has several times been taken in the southern part of California on pepper trees and citrus, but has not yet succeeded in becoming established here. (Photograph December, 1920.)

During the past ten years the gray citrus scale has received no special attention other than regular control, chiefly by means of spraying with oil sprays. The highly refined summer oils have made it possible to make applications while the scales are quite young and have somewhat simplified control measures. Dusting sulfurs have also given control when applied while the scales are still very young.

The barnacle scale, *Ceroplastes cirripediformis* Comstock (Fig. 59), was abundant on pepper trees in southern California (San Diego Co.?) in 1897.[164] The infested trees were severely pruned and destroyed so that the scale did not reappear.

[162] Additional counties added by myself in this year were Butte, Kern, Contra Costa, Solano, Placer, Tehama, and Glenn. It was later found in Santa Clara County.

Essig, E. O., *Injurious and beneficial insects of California*, p. 114, fig. 97 (1913); ed. 2, pp. 140–142, figs. 120–121 (1915); *Insects of Western North America*, p. 290 (1926).

[163] Kuwana, S. I., *Coccidæ of Japan*, V, Jour. Entom. & Zoöl., vol. 6, p. 7, pl. iii, figs. 36–39 (1914).

[164] Austin, F., *Calif. Cultivator*, vol. 12, p. 12 (1898).

In 1920 it was again taken in very limited numbers on a lemon tree in Ventura and in December, 1926, on a pepper tree at Santa Paula.[165] Since then it appears to have again almost disappeared. Being a tropical species it is not likely to become a pest outside of greenhouses in this state.

The brown apricot scale, *Lecanium corni* Bouché, is reported to have been first observed on pear trees at Cordelia, Solano County, in 1881 [166] and was determined as *Lecanium pyri* (Schr.) by Comstock. In 1891 Alexander Craw named it *Lecanium armeniacum*,[167] which name held for a number of years. In ten years this apparently native species had spread throughout the deciduous fruit orchards of the entire state.

It was early discovered that the lime-sulfur-salt spray, as used for the San José scale, would not control this pest. The whale oil and soap spray, resin wash, and the kerosene and distillate sprays as used for the San José, red and black scales were used effectively against it. During the period of 1907-1911, E. K. Carnes in charge of the State Insectary at Sacramento, collected and distributed great numbers of the native parasite, *Encyrtus californicus* Girault (*Comys fusca* Howard), to the fruit growers of the state, without any noticeable results on the scale.

The black scale, *Saissetia oleæ* (Bernard) (Fig. 60), was reported by the Mission Fathers to have been present on olive trees in California as early as 1862.[168] Ellwood Cooper first observed it in the olive groves at Santa Barbara in 1874. It is referred to in his reports as *Coccus olio* (*C. olea* Oliv.) and he states that Alfred Lejourdan (Dejourdan?) first reported the appearance of this scale at Nice, France, in 1743, but it was not described by Bernard until 1782.[169] In 1880, J. H. Comstock [170] gave the first comprehensive account of this insect in California. At that time it was the most common and important citrus pest in the state and was widely distributed throughout southern California and occurred on a great many plants. The males were unknown then. The parasite, *Tomocera californica*, first observed by Comstock, was described by

[165] Essig, E. O., *Insects of W. N. Am.*, p. 292 (1926).
[166] *Pacific Rural Press*, vol. 21, p. 382 (May 28, 1881).
[167] *Destructive insects*, State Bd. Hort. Commrs. of Calif., Div. of Entom., pp. 12-13 (1891).
[168] Board of State Hort. Commrs. of Calif., *First Rept.*, p. 35 (1882). I think that this report is very doubtful.
[169] Calif. Board of State Hort. Commrs., *First Rept.*, p. 36 (1882).
[170] U. S. Commr. of Agr., *Rept.*, 1880, pp. 485-486, pl. viii (1881).

Howard [171] in 1881. In 1883, [172] S. F. Chapin reported it as occurring all along the coast of California where citrus and olive trees were grown.

During the next ten years, or by 1890, the scale occurred throughout all of southern California and in many parts of central California, where climatic conditions were favorable to its growth and reproduction. Nursery trees and plants were the chief means of its dispersion.

The temperate coastal area from San Francisco to San Diego is the most favorable habitat of this insect. It does occur in the warmer interior regions and in the San Joaquin and Sacramento valleys, but is unable to reproduce in sufficient numbers in these hot, dry places to become a pest. I once noted an olive orchard near Corning, heavily infested in 1914, but the next year the pest almost entirely disappeared. The furtherest north I have observed it in the open was on an oleander at Tehama in 1913.

The literature on this insect in California is very extensive, particularly in the horticultural periodicals, but the most complete record so far made of it in this or any other country was prepared by H. J. Quayle and E. W. Rust in 1911.[173]

In this work there is also a bibliography of the important papers, published in various parts of the world to that date. In 1926 I gave a short discussion of the pest with the distribution, hosts, and natural enemies as known at that time.[174]

In 1881 Ellwood Cooper recommended whale oil soap as an effective and cheap remedy for black scale on olive trees.[175] The remedies used by Cooper of Santa Barbara and Levi Chase of Cajon Valley, San Diego County, for the control of black scale on olives " and first recommended by Mr. Cooper, were strong and hot solutions of tobacco. Mr. Cooper now uses a very cheap compound of caustic soda, grease, and tobacco that is worth giving in full: Place a lump of caustic soda the size of one's head in an iron kettle, the largest size used on a no. 9 cooking stove, then pour upon that the strongest decoction of tobacco (already prepared), adding gradually until the soda is dissolved and the kettle nearly

[171] Howard, L. O., *ibid.*, pp. 368–369, figs. 3, 4, pl. 24 (1881).
[172] Calif. State Bd. Hort., *Ann. Rept.*, p. 21 (1883).
[173] *The black scale*, Calif. Agr. Expt. Sta., Bul. 223, pp. 151–200, 24 figs. (1911).
[174] Essig, E. O., *Insects of Western N. Am.*, pp. 22, 36, 199, 267, 299–300, 418, 419, 426 (1926).
[175] Board State Hort. Commrs. Calif., *First Rept.*, p. 39 (1882).

full, then add grease (mutton or beef tallow, or any refuse grease), as much as will be taken up by the tobacco and soda. For use take two or three gallons of this strong solution and add two hundred gallons of previously prepared hot tobacco solution. The whole is

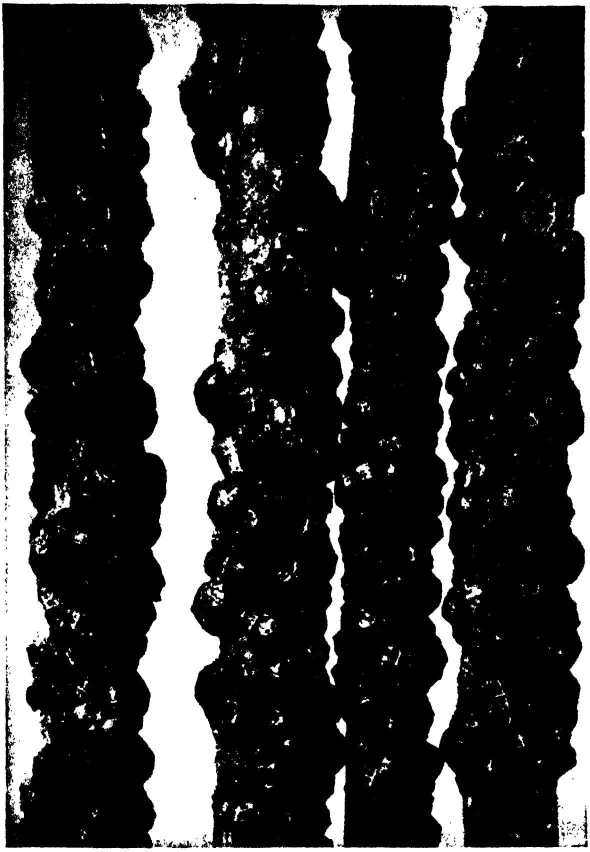

FIG. 60.—The black scale, *Saissetia oleæ* (Bernard), the most important injurious insect in California, was introduced on citrus trees about 1862 and is now widely distributed throughout the southern and central parts of the state on cultivated and wild vegetation. (Specimens collected in Berkeley, October 6, 1920.)

then ready to spray upon the trees, used at a temperature of 130°. This is effectual in destroying the scale, and is good for the tree, leaving it clean and bright. To the strong solution should be added gradually the large amount of tobacco decoction until it has the

right life and foamy appearance needed." [176] In 1883 Matthew Cooke [177] repeats in large part the observations of Comstock and emphasizes the fact "that the black smut is caused by the honey-dew exuded by the females." As remedies he recommended one pound of concentrated lye to each gallon of water; forty pounds of caustic soda and five pounds of potash in forty gallons of water for dormant deciduous trees, and a mixture of one pound of whale oil soap, one-third pound of the above prepared mixture boiled for ten or fifteen minutes to be afterwards diluted one pound to each gallon of water and applied at a temperature of 130° F. for citrus and olive trees. A tobacco spray made by boiling thirty pounds of leaf tobacco in sixty gallons of water was also suggested for citrus trees. A common wash for the control of black scale in 1884 was made of caustic soda, grease, and tobacco.[178]

Until 1900 all of the scale insects infesting citrus, excepting the cottony cushion scale, were controlled in a haphazard way with the best means then available. Among the sprays, whale oil soap was one of the first, then followed the resin wash in 1886 and following this were various types of kerosene emulsion, distillate and water, caustic soda, etc. About this time the distillates became popular. All types of kerosene and distillates with water were tried and considerable burning resulted from using the lighter oils. In 1903, after investigating the results obtained by using distillate sprays, W. H. Volck [179] concluded that kerosene was preferable to the distillates then in use both for citrus and deciduous fruit trees. In 1905 Quayle [180] recommended two types of distillate sprays: the potash distillate composed of distillate 28° Baumé, six gallons; potash or caustic soda, 12 pounds; water, 200 gallons, and the straight distillate, being simply a mechanical mixture of 10 gallons of distillate 28° Baumé and 200 gallons of water. Both were applied in spraying machines with good agitators or the straight distillates were applied in special power spray machines for this purpose. By 1911 the distillates had lost favor and kerosene or water white oil, 20 gallons to 200 gallons of water, applied as a mechanical mixture, was in most general use on citrus trees.[181]

[176] Chapin, S. F., Calif. State Bd. Hort., *Ann. Rept.*, p. 21 (1883).
[177] *Injurious insects of the orchard, vineyard, etc.*, pp. 147–150 (1883).
[178] State Bd. Hort. Commrs. of Calif., *Bien. Rept.*, pp. 33–34 (1884).
[179] *Spraying with distillates*, Calif. Agr. Expt. Sta., Bul. 153 (1903).
[180] Quayle, H. J., Calif. Agr. Expt. Sta., *Bul. 166*, pp. 22–23 (1905).
[181] Quayle, H. J., *ibid.*, *Bul. 214*, p. 506 (1911).

By 1907, considerable damage to citrus trees was becoming apparent from the continued use of oil sprays and the California Fruit Exchange asked for relief. This request was made to the Bureau of Entomology, U. S. Department of Agriculture, and was met by delegating R. S. Woglum to California in order to further perfect the system of HCN fumigation, which had fallen into the discard. This excellent piece of work begun in 1907 and continued until 1920 gave the needed relief. Better tents were secured, a system of measuring the dosage was adopted and the whole process perfected and simplified, beyond anything in the past, although the old pot system of generating the gas was still adhered to. A great advance was made in generating the gas with the invention of the fumigating machines in 1912 which were generally adopted in 1915 and continued to be used in some quarters until 1924. The next important step was the commercial production of liquid HCN and the proper apparatus for applying the same under the fumigating tents in 1919. This is the method in vogue at this time. An interesting development in the use of cyanide dust instead of gas was begun in 1922 by H. J. Quayle and is still in the progressive stage.

Because of the scarcity and high price of cyanide during the World War, 1916–1918, many substitutes for fumigation were resorted to in the form of sprays. Soap powders were very extensively used, particularly for black scale. Distillate emulsions and miscible oils became popular and were extensively used until the manufacture and sale of highly refined so-called summer oil sprays, which appeared in 1924. These latter have met with marked success, not only for the control of scale insects on citrus trees, but also as summer sprays for red spiders on both citrus and deciduous fruit trees.

The first natural enemy of importance attacking the black scale was, *Tomocera californica* Howard, observed by J. H. Comstock near Los Angeles in August, 1880.

On his first mission to Australia, 1888–1889, Albert Kœbele collected the larva of a coccid-feeding moth, *Eublemma cocciphaga* (Meyr.),[182] which he forwarded to California as an enemy of the black scale. The first lot was never colonized and other sendings later in 1891 apparently also perished after being liberated in the orchards of the state.

[182] Calif. State Bd. Hort., *Ann. Rept.*, 1891, pp. 215–216 (1892). (*Thalpochares.*)

In May, 1892, Kœbele forwarded from Australia to California the black ladybird beetle which was the first successful introduction of a natural enemy for the black scale. See *Rhizobius ventralis* (Er.).[183]

The steel-blue ladybird beetle, *Orcus chalybeus* (Bdv.) was also sent to California from Australia by Kœbele in 1892 and became permanently established only in Santa Barbara County where it preys upon the black scale, red scale, and purple scale, but is of no economic importance in the control of any of the three.

The scutellista *Scutellista cyanea* Mots., was introduced in California in 1902 from South Africa and for a few years promised great results in the control of the black scale, but hyper-parasites soon cut down its efficiency. (See scutellista, p. 335.)

An attempt to secure a parasite of the immature stages of the black scale, was successful by the introduction from Australia of the South African parasite, *Metaphycus lounsburyi* (Howard),[184] in 1918 by E. J. Vosler, who collected it in Australia and forwarded it to California, and H. S. Smith, who reared and distributed it to the citrus growers of southern California in 1919–1920. For two or three years this parasite did phenomenal work in controlling the black scale in the coastal regions of the southern part of the state, but the secondary parasite, *Quaylea whittieri* (Gir.), was so effective in its attacks on the larvæ of *Metaphycus* that the latter was rendered almost as commonplace as scutellista.

The Italian pear scale, *Diaspis piricola* (Del Guercio), was first taken in California in 1882 by Matthew Cooke and determined by Comstock as *Diaspis ostreæformis* Curtis.[185] It was first styled the Italian pear scale, *Diaspis pyricola* in a leaflet entitled The Pacific Tree and Vine printed at San José, Calif., January 13, 1900. The complete identity of the species was cleared by C. L. Marlatt the same year.[186] The dissemination of the scale in California has been very slow and it is at present confined to the orchards and plants of the California Christmas berry in the counties of the San Francisco Bay region where it is sometimes a pest. Specimens were also taken on the California Christmas berry from

[183] *Ibid., Fourth Bien. Rept.*, 1893–1894, pp. 5, 436–437 (1894).

[184] Smith, H. S., and Compere, H., Calif. State Dept. Agr., *Mthly. Bul.*, vol. 9, pp. 310–320 (1920).

Smith, H. S., *ibid.*, vol. 10, pp. 127–137 (1921).

[185] Cooke, Matthew, *Injurious insects of the orchard, vineyard, etc.*, pp. 112–113 (1883).

[186] *The European pear scale*, Entom. News, vol. 11, pp. 590–594 (1900).

Goleta, Santa Barbara County, in 1915 by A. A. Brock.[187] Control measures were indefinite until worked out by P. R. Jones in 1910,[188] when the distillate oil emulsions and crude oil emulsions were found effective.

The parlatoria date scale, *Parlatoria blanchardi* (Targioni),[189] was described as *Coccus blanchardi* by Targioni-Tozzetti [190] in 1869 from specimens collected in Algeria. It was first introduced into the United States on fifty-four date palm offshoots imported from Cairo, Egypt, and nine offshoots from Algeria in 1889.[191] It was noted in 1890 on the palms which were held in the experimental grounds of the U. S. Department of Agriculture at Washington, D. C. Inasmuch as these date palms were intended for planting in the Southwest, the entomologist was requested to destroy the scale before the plants were released. Lacking first-hand knowledge concerning the habits and control of the pest, experiments were made with applications of different strengths of kerosene emulsions and resin wash. After repeated applications of sprays and a thorough brushing of the plants followed by more sprays, the offshoots were shipped to Arizona and California, October 10, 1890. Nine of them were set out at the Experiment Station Farm at Phœnix, Arizona, and others were planted at the Experiment Stations at Tulare and Chino, California. In 1893 J. W. Toumey noted that

[187] Essig, E. O., *Inj. and Ben. Ins. Calif.*, ed. 2, p. 172 (1915).

[188] U. S. Dept. Agr., Bur. Entom., *Bul. 80*, pt. viii (1910).

[189] *Insect Life*, vol. 3, pp. 441–443 (1891).

Cockerell, T. D. A., *The scale insects of the date palm*, Ariz. Agr. Exp. Sta., Bul. 56, pp. 185–192, 1 fig., pls. 1–2 (1907).

Forbes, R. H., *The extermination of date-palm scales*, *ibid.*, pp. 193–207, figs. 2–5 (1907).

The gasoline torch treatment of date palm scales, Jour. Econ. Entom., vol. 6, pp. 415–416 (1913).

King, H. H., *Rept. Wellcome Res. Labs.*, Khartoum, vol. 3, p. 240 (1908).

Popenoe, P. B., *Date growing* (Altadena, Calif., West India Gardens, 1913), pp. 149–151.

Essig, E. O., *Injurious and beneficial insects of California*, pp. 139–140, fig. 123 (1913); ed. 2, pp. 191–192, fig. 167 (1915).

Insects of Western North America, pp. 304–305, fig. 188 (1926).

Buxton, P. A., *Insect pests of dates in Mesopotamia*, Bul. Entom. Research, vol. 11, pp. 295–298 (1920–1921).

Shamblin, A. J., *Eradication and control of date scale*, Rept. First Date Growers' Inst., Coachella, Calif., pp. 13–14 (April, 1924).

Bottel, A. E., *Quarantine protection of the date industry*, *ibid.*, pp. 15–16.

Stickney, F., *Date palm insects*, *ibid.*, pp. 16–17.

Also see references to the red date scale.

[190] Targioni-Tozzetti, G., *Catalogue*, p. 32 (1769); *Mem. Soc. Zoöl. France*, vol. 5, pp. 69–82 (1892) (*Aonidia*).

[191] Popenoe, P. B., *Date growing in California*, Calif. State Hort. Com., Mthly. Bul., vol. 1, p. 870 (1912).

two of the palms at Phœnix were badly infested with the date palm scale which had survived the original treatments at Washington. These infested palms were again sprayed with kerosene emulsion in that year and another application the following year, but the insect was still present in 1895. Following these initial treatments yearly applications of whale oil soap were made until 1898 without reducing the numbers of the coccid. A more rigorous program of treatments was instituted consisting of applications of distillate

FIG. 61.—Date offshoots assembled along the Persian Gulf awaiting shipment to the United States. The U. S. Department of Agriculture has endeavored to introduce only the best varieties. Unfortunately the date palm scales were introduced with the first offshoots brought into the country. (After David Fairchild, 1916.)

sprays in 1903, HCN fumigation in 1897–1907, and finally as a climax, the gasoline torch or flame treatment in 1905. None of these measures, however, served to entirely eradicate the pest.

The palms planted at Tulare, California, were pronounced free of pests, but those at Chino were soon found to be infested with the scale and were twice fumigated with HCN.[192] In 1894 an importation of date palms to be planted at Pomona, California, were observed to be badly infested with the pest by S. A. Pease,[193] and

[192] Calif. State Bd. Hort., *5th Bien. Rept.*, 1895–1896, p. 42 (1896).

[193] *Ibid.*, *4th Rept.*, 1893–1894, p. 439 (1894). Alex. Craw wrongly determined the scale as *Parlatoria proteus* (Curtis).

the plants were fumigated. The date palm scale was also probably introduced into the commercial date orchards at Heber in 1901. With the importation into California and Arizona of some 42,000 additional date offshoots from 1914 to 1922, the pest was generally distributed throughout the date-growing areas of these states. According to Shamblin [194] of the 35,000 offshoots imported up to and including the year 1915, probably 20,000 were infested with *Parlatoria blanchardi* (Targ.). In 1909 the insect was reported in Yuma, Maricopa, and Pinal counties in Arizona; and in Webb County in Texas. Since then it has spread throughout most of the rapidly increasing areas devoted to date culture. In 1929 approximately 136,000 date palms in Coachella Valley and 30,000 in Imperial Valley, California, and 30,000 in the Salt River Valley and 18,000 near Yuma, Arizona, were more or less infested.[195]

To prevent the further spread of the pest the Federal Horticultural Board, U. S. Department of Agriculture in 1913, passed an act prohibiting the movement of infested palms from one state into clean districts in another state. This action was followed by the California Date Palm Law, approved April 2, 1915, which was intended to prevent the further spread of the date palm scales in California.

In 1922 a coöperative project for exterminating the date palm scale in Arizona was undertaken by the Arizona Agricultural Experiment Station and the Federal Horticultural Board. On April 17th, 12,610 date palms had been inspected of which 281 were infested with *Parlatoria*. Of these 185 were destroyed and the others pruned and torched. The infested trees at the experimental farm at Yuma were reduced from 23 in April, 1922, to one in February, 1923. At Tempe but one tree was found infested in the experimental orchard. Five carloads of offshoots were imported into the Salt River Valley from April, 1922, to May, 1923.[196]

In 1928 a federal appropriation of $40,000 was made to initiate a coöperative campaign of eradicating [197] the date palm scale in California and Arizona. California appropriated $25,000 for the

[194] Shamblin, A. J., *op. cit.*, p. 13.
[195] Boyden, B. L., *Calif. Cult.*, vol. 72, p. 593 (May 18, 1929).
[196] Bartlett, O. C., *Date palm scale eradication*, Proc. 5th Conv. Western Plant Quarantine Bd., Calif. State Dept. Agr., Mthly. Bul., vol. 12, p. 283 (1923).
[197] *Calif. Cult.*, vol. 70, p. 487 (Apr. 28, 1928); vol. 72, pp. 581–593 (May 18, 1929).

work in this state.[198] B. L. Boyden, U. S. Plant Quarantine and Control Administration, was placed in charge of the campaign and the work is now under way.

In 1929 the known distribution of the date palm scale outside of the United States was as follows: Asia—Arabia, Mesopotamia, Palestine, and India; Africa—Algeria, Egypt, Tripoli, Tunis, Sahara, Italian Somaliland; Australia—Northern Territory.

The oyster shell scale, *Lepidosaphes ulmi* (Linn.) (Fig. 62), determined as *Aspidiotus conchiformis*, was the first known scale insect in California to infest fruit trees and was undoubtedly one of the species referred to by A. Kellogg in 1870 and W. P. Gibbons in 1872.[199] In the same year it was taken on laurestinus in San Francisco by R. H. Stretch.[200] It was included in all the lists of scale insects. The distribution is general, but the insect has always been more in evidence in unsprayed orchards in northern California.

This scale insect was introduced into the Yosemite Valley on apple trees at an early date and has thrived nuusually well. It has also attacked the native poplars and willows severely and during the summer of 1928 I noted most of the willows growing on the valley floor completely encrusted and many clumps entirely killed by the insect.

The purple scale, *Lepidosaphes becki* (Newm.), was first observed at Downey, California, in 1890, upon citrus trees introduced from Florida in 1889.[201] A great deal of excitement was produced by this discovery, because growers in California had been previously warned regarding the danger of introducing this and other citrus pests from Florida.[202] Its spread throughout the mild coastal region of southern California was rapid so that by 1910 it occurred from San Diego to Santa Barbara counties. It does not thrive in the warmer inland districts so has never been a pest in either San Bernardino or Riverside counties. The control measures have been practically the same as for red scale. In some sections, particularly in Ventura County, this scale has, by strenuous efforts, been practically eradicated.

[198] Jacobsen, W. C., Calif. State Dept. Agr., *Mthly. Bul.*, vol. 17, pp. 653–654 (1917); vol. 18, pp. 59–60 (1929).
[199] *Pacific Rural Press*, vol. 4, p. 289 (Nov. 9, 1872).
[200] Calif. Acad. Sci., *Proc.*, vol. 4, p. 265 (1873).
[201] *Insect Life*, vol. 3, pp. 23–24 (1890).
[202] *Ibid.*, vol. 2, pp. 341–342 (1890).

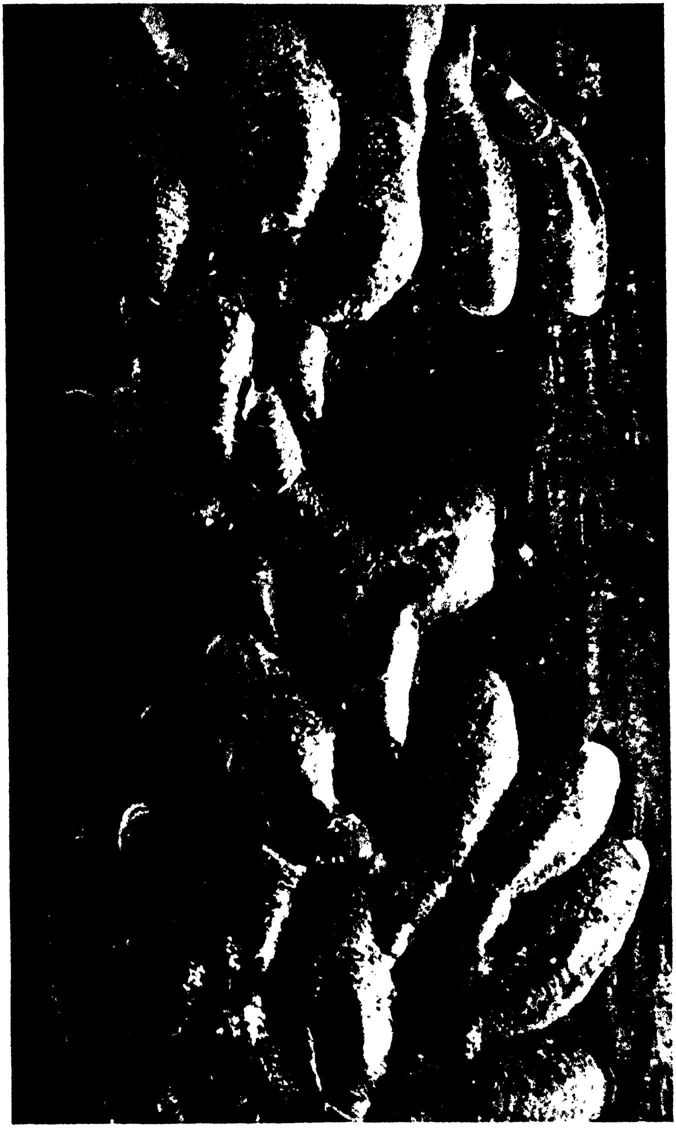

FIG. 62.—The oyster shell scale, *Lepidosaphes ulmi* (Linn.), is a cosmopolitan insect early introduced into North America and now occurring throughout the country. It was also early introduced into California on nursery stock and is now well established on the native vegetation throughout the state. It is particularly abundant on willows and poplars in the Yosemite National Park. (Photograph of specimens taken on willow at Palo Alto, October 5, 1928.)

The greedy scale, *Aspidiotus camelliæ* (Signoret), was early observed to attack fruit trees in California and by 1880 was generally known as the "Santa Cruz apple and pear scale." It was described by Comstock in his report of 1880 along with the San José scale as *Aspidiotus rapax*, but as this scale proved to be the same as the European species described by Signoret in 1869, the later Comstock name became obsolete.

This apparently indigenous scale is abundant throughout the state on native trees and shrubs, particularly California laurel, willow, ceanothus, and poplar, and can always be found on apple, pear and fruit trees and ornamentals, but never in sufficient numbers to be a serious pest. On pear trees in Santa Cruz, Santa Clara, and Alameda counties it has often become sufficiently abundant to cause some worry and a few growers have applied oil sprays for its control inasmuch as the standard lime-sulfur does not kill it. S. F. Chapin called attention to it as an orchard pest in 1882,[203] and Albert Kœbele tested out various sprays for its control in 1887.[204]

The oleander scale, *Aspidiotus hederæ* (Vallot), a similar native species, appears to have first been mentioned by Comstock as *A. nerii* Bouché in his Report on Scale Insects.[205] Specimens were collected on the leaves of Magnolia of the University Campus in 1882 by C. H. Dwinelle and the same trees are still infested with this scale. It now occurs on native trees and shrubbery, fruit and ornamental trees, shrubs, etc., throughout the entire state.

The San José scale. The history of the development of the San José scale, *Aspidiotus perniciosus* Comstock (Fig. 63), in California is particularly interesting because it marks not only the recognition of the importance of the life history study of this and other injurious scale insects, but also the discovery and perfection of lime-sulfur and oil sprays as insecticides.

Soon after the establishment of deciduous fruit orchards in California progressive growers began to notice scale insects on the trees. In 1870 A. Kellogg called attention to these and suggested spraying with solutions of potash and urged the protection of birds as a natural check. In 1872 W. P. Gibbons [206] gave a lecture on scale insects in which he referred to at least five unnamed species

[203] Calif. State Board Hort., *First Rept.*, pp. 65–66 (1882).

[204] *Rept. on experiments against scale insects*, U. S. Dept. Agr., Rept. for 1887, pp. 143–147 (1888).

[205] U. S. Commr. Agr., *Rept.*, 1880, p. 451 (1881).

[206] *Pacific Rural Press*, vol. 4, p. 289 (Nov. 9, 1872).

of *Aspidiotus* in California and pointed out the danger of distributing these pests on nursery stock. According to Howard and Marlatt [207] "it first reached California on trees imported from Chile by the late James Lick in 1870." [208] This evidence is largely based on the fact that the pest was first noted in the orchard owned by James Lick who was importing at that time large numbers of fruit

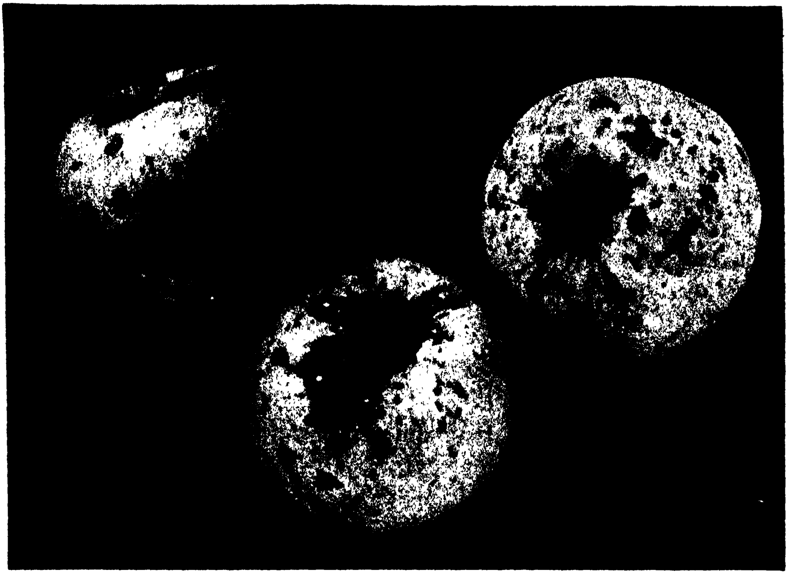

FIG. 63.—The San José scale, *Aspidiotus perniciosus* Comst., an Asiatic species, was introduced into California prior to 1870 and spread with great rapidity and disastrous results throughout the deciduous fruit orchards. It was first noted in the East in Virginia in 1893 and quickly became distributed throughout the entire country. In California it declined after 1909 and for the past ten years has been of no great economic importance.

and ornamental trees. Matthew Cooke [209] reports that fruit shippers first noted the effects of the San José scale on fruit in San José as early as 1873. By 1879 scale insects were regarded as important pests to the fruit trees in the Santa Clara Valley and in that year, specimens sent to J. H. Comstock, entomologist for the U. S. Department of Agriculture, were determined as the oyster shell

[207] Howard, L. O., and Marlatt, C. L., *The San José Scale*, U. S. Dept. Agr., Div. Entom., Bul. 3, n. s., p. 10 (1896).

[208] James Lick also imported flowering peaches, cherries, etc., from Japan about the same time and it is not unlikely that the pest could have been introduced in that way.

[209] *Injurious insects of the orchard, vineyards, etc.*, p. 60 (1883).

scale and an unknown species.[210] The latter was, prior to its description, locally known as the small round black scale.[211] In the year 1880 J. H. Comstock arrived in California to study the scales on orange trees. On September 24 of that year he gave a lecture before the State Horticultural Society (presumably at San Francisco) on Scale Insects Injurious to Fruit and Other Trees. In this lecture he discussed the black scale and red scale, but made no mention of the San José scale as such. His remedy for scale insects was: 1 pound of concentrated lye, 1 pint of gasoline or benzine, ½ pint of oil, 5 gallons of water. Comstock did not describe the San José scale until his return to Washington when his report was issued in 1881.[212] During this same year a great many tests were made chiefly with lye washes; kerosene; gasoline; whale oil soap and sulfur mixture; soft soap; sulfur and tobacco; kerosene, whale oil soap and borax; crude carbolic acid; crude petroleum, and so on. These were first applied during the summer or fall when the trees were in foliage, but in 1882 it was discovered that they could be applied effectively against the scale during the winter when the trees were dormant and less susceptible to spray injury. Trees were covered with tents and trial tests made by fumigating with carbon disulfide, live steam and sulfur fumes, live steam and kerosene. These tests resulted in the death of the trees.

In 1881, also, holes were bored in the trunks of the trees and patented cures administered [213] without any real effect upon the pests. By 1882 the San José scale was found in twelve counties in the state and in twenty counties the next year. It was not discovered in the eastern part of the United States until 1894.

In 1882, S. F. Chapin, member of the Board of State Horticultural Commissioners, discussed at length the insect as a pest in California and gives the results of twenty-six experiments with various compounds of soap, lye, kerosene, gasoline, sulfur, tobacco, carbolic acid and seven experiments with steam. He also gave some information on tests made with crude petroleum in 1879–1880, 1880–1881 and 1881–1882. He concluded that concentrated lye, one pound to one gallon of water, was the most desirable

[210] *Pacific Rural Press*, vol. 18, p. 328 (Nov. 22, 1879); vol. 19, p. 24 (Jan. 10, 1880).

[211] *Pacific Rural Press*, vol. 22, p. 104 (Aug. 13, 1881).

[212] J. H. Comstock, U. S. Dept. Agr., *Rept. for 1880*, p. 304 (1881).

[213] Calif. State Board of Horticultural Commissioners, *First Rept.*, pp. 78-80 (1882).

remedy for the San José scale, and should be applied with an extension rod.[214]

The concentrated lye washes, 1 pound to 1 or $1\frac{1}{2}$ gallons of water, were most generally used as the materials were easily available and not expensive. That they were unpleasant to handle may be seen from the following lines:[215]

Every printer knows,
I suppose,
That an eye
Full of lye
Is very nearly—well
It hurts for a spell;
And printer's lye is not
Nearly as hot
As the stuff the farmer throws,
Through the hose
On the trees.

Commercial sprays also began to appear at that time.

A standard wash recommended by S. F. Chapin, State Inspector of Fruits, in 1884, was called the Whale Oil and Iron Compound made of whale oil, concentrated lye, tobacco, sulfur, coal oil and sulfate of iron. It was considered most effective in the control of both the San José scale and the cottony cushion scale.

E. W. Hilgard issued a bulletin on alkaline washes for fruit trees in 1886 [216] in which he gave methods of preparing lye and potash compounds which were in vogue as late as 1888.

The combination of lime-sulfur and salt was first used as a spray for fruit trees in California by F. Dusey of Fresno [217] in 1886.

In 1887–1888 I. H. Thomas and A. T. Covell recommended lime sulfur and salt to the fruit growers of the state. Their formulæ were as follows:[218]

I. H. Thomas		A. T. Covell
25 lbs.	unslaked lime	50 lbs.
20 lbs	sulfur	20 lbs.
15 lbs.	salt	15 lbs.
60 gals	water	60 gals.

[214] *Ibid.*, pp. 69–86 (1882).
[215] Gally, I. W., *Pacific Rural Press*, vol. 23, p. 45 (Jan. 21, 1882).
[216] Calif. Agr. Expt. Sta., *Bul. 51* (1886).
[217] H. J. Quayle, Calif. Agr. Expt. Sta., *Bul. 166*, p. 6 (1905).
[218] State Board of Hort. Commrs. of Calif., *Rept. for 1887–88*, p. 277 (1888).

In 1891 the formula as modified was as follows:[219]

Unslaked lime	40 lbs.
Sulfur	20 lbs.
Salt	15 lbs.
Water	60 gals.

H. J. Quayle, in 1904,[220] recommended a formula which still contained salt.

Unslaked lime	30 lbs.
Sulfur	15 lbs.
Salt	10 lbs.
Water	60 gals.

Salt was proven to be decidedly injurious to the trees and was omitted from the formulæ in 1906–1909 and afterwards.

Commercial compounds of lime-sulfur began to appear in 1907 and very largely replaced the homemade mixture by 1914.

Regarding the importance of the San José scale, L. O. Howard, Chief of the Bureau of Entomology, U. S. Dept. of Agriculture, had the following to say in 1911:[221]

> A few years later the San José scale was discovered in the eastern United States. The tremendous effect of the spread of this most injurious species upon the popular estimation of the value of entomological knowledge can hardly be overestimated. This spread alone is responsible probably for more legislation in this country and in other countries than all the other features of entomology combined. The San José scale literature published in the last sixteen years covers hundreds of thousands of pages, and hundreds of thousands of dollars have been lost through the work of the insect. But through the operation of new state laws many additional entomologists have been employed, and through their work millions of dollars have been saved.

The general spraying program which followed the development of commercially prepared insecticides and adequate spraying equipment was extended to all parts of the state by 1910 and lime-sulfur, which was used extensively for scale insects, also became a popular fungicide and maintained first place in the latter rôle until 1922, when considerable injury to apricot and peach trees was caused by its continued use. The manufacture of basic arsenate of lead which could be safely applied in combination with Bordeaux mixture also decreased the use of lime-sulfur, particularly on

[219] State Board of Hort. Commrs. of Calif., *Ann. Rept.*, p. 199 (1891).
[220] Calif. Agr. Exp. Sta., *Bul. 166*, p. 6 (1905).
[221] *Entom. News*, vol. 22, pp. 102–103 (1911).

apples and pears. The very extensive use of lime-sulfur up to 1922 accounts for the almost complete elimination of San José scale from the orchards of the state. So much so that it is with difficulty that the pest can be found at all. Since this change from lime-sulfur the winter oil sprays have been extensively used throughout

FIG. 64.—The red scale, *Chrysomphalus aurantii* Mask., was introduced into southern California in 1872–1873, and has since become one of the most important pests of citrus trees. Strains or distinct varieties, resistant to HCN fumigation, were introduced or developed in recent years. (Photograph furnished by G. E. Woodhams, 1929.)

the west for the control of this and other scales on deciduous fruit trees. Just what is going to happen to orchards not so regularly sprayed with oil as they were in the past with lime-sulfur remains to be seen, but it looks as if there might be a return of the San José scale in greater numbers than during the past fifteen years.

There have been many attempts made in California to change the common name of this insect. On April 13, 1886, at the conclu-

sion of the report of W. M. Boggs, State Inspector of Fruits, before the State Board of Horticulture, E. Kimball, a member of the board "moved that wherever the words San José scale appear, it be stricken out and its true name *Aspidiotus perniciosus*, substituted, and that hereafter this insect be so designated and not called as heretofore erroneously, the San José scale. This motion was unanimously agreed to." [222] The late A. J. Cook, when state horticultural commissioner (1911–1916), did all he could to change the common name to pernicious scale, but without avail!

The red scale, *Chrysomphalus aurantii* Mask. (Fig. 64), was introduced into San Gabriel on a budded orange tree purchased by L. J. Rose from a hothouse in San Francisco in 1872–1873. Its presence was not noticed for two or three years when an attempt was made to exterminate it. This was not successful and in the fall and winter of 1878–1879 it had spread throughout his orchard and to those of his neighbors. It is supposed also that the pest was again introduced into Los Angeles directly from Australia on Lisbon lemon trees by Don Mateo Keller about the same time.[223] In 1880 specimens sent to J. H. Comstock were determined as a new species, *Aspidiotus ficus*. Kerosene and water were used as a spray for the red scale in 1880, but gave way to fumigation when that process was perfected for the cottony cushion scale. Satisfactory results, however, were not obtained until the fumigation with HCN was placed upon a firm basis by R. S. Woglum in 1907–1909. At the present time there are certain areas in southern California in which the red scale appears to successfully resist ordinary methods of fumigation. In these places and elsewhere, highly refined oil sprays are used instead of, or as an alternate with HCN fumigation.

ALEYRODIDÆ (Family). White Flies.

The citrus white fly, *Dialeurodes citri* (Riley and Howard) (*Aleyrodes*), first received the attention of Ellwood Cooper, State Commissioner of Horticulture, in 1905. In order to protect the citrus interests of California he issued, on October 3rd of that year, the first state quarantine order (Quarantine Order No. 1, Citrus White Fly), in which it was stated that inasmuch as this pest did

[222] State Board Hort., *Rept.*, 1885–1886, p. 565 (1887).
[223] Holt, L. M., *Pacific Rural Press*, vol. 19, p. 67 (Jan. 31, 1880).

not exist in California that all citrus fruits and citrus nursery stock imported into the state from Florida be held for destruction or shipment out of the state. On March 2, 1906, the order was amended to prohibit all oranges, lemons, citrus or other nursery stock, as well as herbaceous and other plants from Florida and Louisiana.

Early in May, 1907, the white fly was discovered in the city of Marysville and caused great alarm from the citrus growers throughout the state. Cooper at once endeavored to cope with the situation and in June issued an order stating that the white fly was present in Marysville and that there was no known effective remedy in the form of sprays or fumigation and that in order to effect eradication of the pest " All infested trees, plants or other forms of vegetation upon which the said *Aleurodes citri* feeds, shall be immediately destroyed by the removal and burning of all portions liable to infestation. In the case of trees, the whole foliage-bearing surface must be removed, leaving only the bare trunks, and these trunks must be treated with a thorough coating of whitewash composed of quicklime slaked with water." [224] A campaign of eradication was begun on June 22nd and the greater part of the defoliation was done during July. The original infestation was chiefly along the street car tracks between B and I Streets. There was much criticism of the work as done at Marysville. C. W. Woodworth [225] published two circulars on the subject, which had much to do with the removal of Cooper from office at the end of his term (Fig. 65).

In August a small infestation of white fly was discovered at the home of W. S. Tevis, owner of the Stockdale ranch, near Bakersfield, and prompt and effective action apparently completely eradicated the pest at that locality as it has never been found there since. The species taken there is supposed to have been the woolly white fly, *Dialeurodes citrifolii* (Morgan) (*Aleyrodes nubifera* Berger).

In October an infestation covering twelve and one-half blocks was discovered at Oroville. With the experiences of the work at Marysville a more thorough eradication campaign was planned at Oroville. It was decided to use the same methods of defoliation and burning in the infested area and to fumigate the trees adjacent

[224] *Pacific Rural Press*, vol. 74, p. 11 (July, 1907).

[225] *White fly in California*, Calif. Agr. Expt. Sta., Circ. 30, 16 pp., 12 figs. (June, 1907).

White fly eradication, *ibid.*, Circ. 32, 15 pp., 11 figs., 1 map (July, 1907).

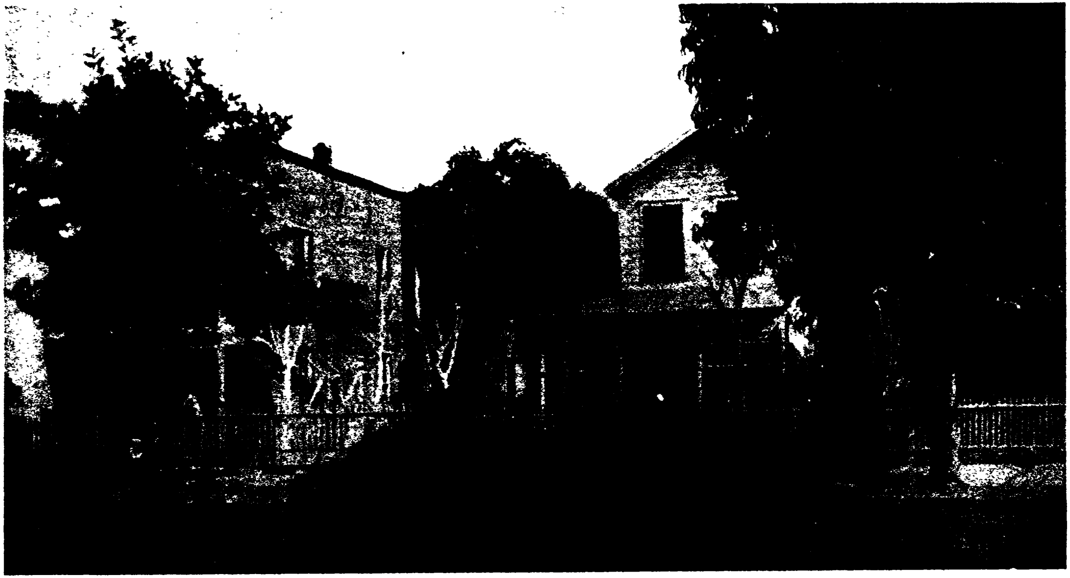

FIG. 65.—The citrus white fly campaign at Marysville, California. The photograph shows method of cutting back the orange trees as well as a pile of brush awaiting removal and burning. (After C. W. Woodworth, July, 1907.)

thereto. The carrying out of the orders was placed in the hands of E. K. Carnes, F. Maskew, S. Strong, and B. B. Whitney for the State Commissioner of Horticulture and C. J. Dreher, the County Horticultural Commissioner, and his inspector, E. Mills, for the county. The procedure involved (1) an inspection of every portion of the city to ascertain the exact limits of infestation, (2) the plotting of every infestation and designating all the infested plants, and (3) the tagging of every infested plant. Legal notices were served on the property owners October 8, 1907, and fumigation was begun December 1st and completed by February 1st, 1908, while the actual eradication work was done between February 1, and February 20, 1908. The known host plants in California at that time were: all varieties of citrus, chinaberry, *Viburnum nudum*, cape jasmine, Japanese persimmon, California privet, golden privet, mock orange, osage orange, and lilac.[226]

The work at Marysville, begun in 1907, was also continued during the early spring of 1908 by J. W. Jeffrey, who succeeded Cooper as State Commissioner of Horticulture in October, 1907. In May and June no traces of the white fly were found at Oroville. It was again found at Marysville in 1909 but was so reduced in numbers that it was ignored there for a number of years.

In April, 1909, two infestations of this insect were discovered at Sacramento, but the action taken for its eradication does not appear to have been recorded in print.

Upon his appointment as State Commissioner of Horticulture in October, 1911, A. J. Cook at once ordered an inspection of all the areas formerly infested by the citrus white fly. Careful examinations failed to reveal its presence anywhere excepting in Marysville, where it had gained considerable headway since 1908. Plans were formulated to conduct a defoliating campaign by using a mixture composed of 5% spray distillate and 95% water with six pounds of caustic soda to every 100 gallons. The work was intrusted to G. E. Merrill in coöperation with G. W. Harney, County Horticultural Commissioner, and was done during December, 1911, January, and February, 1912. Citrus trees, ivy and privet hedges on 45 city blocks were sprayed, the applications being made with a power sprayer at a pressure of from 180 to 200 pounds. Defoliation

[226] Calif. State Com. Hort., *Bien. Rept.*, 1907–1908, pp. 13–15 (1909).
Carnes, E. K., *Practical work in combating the white fly*. Proc. 33d Calif. State Fruit Growers' Conv., pp. 133–144 (1908).

was not secured as expected, but the pest was considerably reduced in numbers. From April 15th to the 25th all of the infested trees were fumigated.[227]

In 1911 the pest was again observed in Sacramento and all of the infested trees were removed and burned.[228]

It was again found in limited numbers at Marysville by E. J. Branigan in December, 1913. In October, 1914, Branigan made a careful inspection of the city and found sixty-one separate infestations of which thirty-seven were rated as light, seven medium, and seventeen heavy. In view of the fact that eradication seemed impossible it was decided to reduce the pest by spraying. Tests with various sprays conducted at Marysville, December 7, 1914, showed good results from the applications of both miscible oils and distillate oil emulsions. The work was begun on February 15, 1915, and finished March 16. The spray was applied as before and good results were obtained in killing the young on the foliage, without any injurious results to the trees.[229]

At the request of the California State Commission of Horticulture, E. W. Berger reviewed the status of the citrus white flies in Florida [230] and listed the food plants on which the citrus white fly has matured, in the order preferred by the insect.

On November 14, 1918, the citrus white fly quarantine (Order No. 21) was amended (Amendment No. 1) to permit the bringing into the state dormant nursery stock of the persimmon or pear varieties from the southern states upon receipt of a permit from the State Commissioner of Horticulture.[231]

In 1923 it was announced by the Director of Agriculture, that "the citrus white fly continues to be present on citrus trees and certain ornamental plants in portions of Sacramento, Marysville and Yuba City. This pest has made very little spread from areas which have been infested for nearly twenty years but the mild weather of the past season apparently favored its increased development. The infestation is of no concern to the citizens of these

[227] Merrill, G. E., *The white fly in California*, Calif. State Com. Hort., Mthly. Bul., vol. 1, pp. 14–15 (1912).

The white fly work at Marysville, *ibid.*, pp. 62–63, 242–243 (1912).

[228] Cook, A. J., Calif. State Com. Hort., *Mthly. Bul.*, vol. 1, pp. 374, 536 (1912).

[229] Weldon, G. P., *White fly at Marysville*, Calif. State Com. Hort., Mthly. Bul., vol. 4, pp. 386–388, fig. 77 (1915).

[230] Berger, E. W., *White flies of citrus*, Calif. State Comm. Hort., Mthly. Bul., vol. 6, pp. 298–307, figs. 97–106 (1917).

[231] Calif. State Com. Hort., *Mthly. Bul.*, vol. 8, p. 37 (1919).

towns, but is a constant source of danger to some of California's commercial citrus fruit districts. This office, with the coöperation of the county horticultural commissioners from the counties concerned, is undertaking control measures to reduce the infestation as far as possible until some future time when a final effort toward complete eradication of the pest may be considered feasible." [232]

Tests were accordingly made early in 1924 with oil sprays in order to defoliate the trees, but proved as unsatisfactory [233] as in 1911.

The state of Arkansas was added to the list of quarantined states by an amendment issued July 19, 1923, and the state of Tennessee by an amendment issued July 8, 1925. [234]

In 1925, due to a rapid increase in the numbers of the white flies in the infested areas, agitation was begun by the citrus growers of southern California, through the California Fruit Growers Exchange, to eradicate once and for all the citrus white fly in California. The state legislature passed a bill appropriating $40,000 for this purpose on condition that the aforesaid association raise a like amount, which was done. Accordingly steps were taken by the State Department to find all possible measures which would secure complete defoliation of the evergreen host plants. Experiments on a large scale were conducted on the Nimbus Ranch near Sacramento managed by J. B. McFarland. In these experiments hydrocyanic acid gas was tested at strengths from 100 to 300 schedules, also in conjunction with Bordeaux mixture and with sulfate of copper solutions (the work being conducted in the daytime). In addition there were used certain strengths of a commercial weed killer. No complete foliage drop was secured in any case, though with the weed killer a certain amount of the sprayed foliage was killed but did not fall. While these results were not unexpected, it is necessary to have concrete evidence. [235]

As a further preparation for a campaign of eradication it was considered necessary to prepare court proceedings to test the validity of enforced measures on hosts presumed to be infested because immediately adjacent to known infested trees or in the infested area, upon which, however, no white flies could be found. "The case resulted in a decision by the superior court of Sacramento

[232] *Ibid.*, vol. 12, p. 361 (1923).
[233] *Ibid.*, vol. 13, p. 162 (1924).
[234] *Ibid.*, vol. 14, p. 159 (1925).
[235] *Ibid.*, vol. 14, p. 171 (1925).

County to the effect that presumption of infestation merely because of neighboring infestations was not sound; that action under the law was warranted only on a basis of revealed infestation." [236] After much deliberation of all parties interested in the problem it was finally decided that complete eradication was hopeless and that the only expedient procedure was to adopt a program of reduction and control by spraying with the expectation of keeping the pest reduced to such an extent that it would cease to be a menace. An inspection showed one hundred and ninety-one blocks infested in Sacramento, about one hundred and nineteen in Marysville, and ten in Yuba City, all of which were estimated to contain more than ten thousand host plants and involved sixteen hundred property owners.[237] In March, 1927, the spray program was well under way. D. B. Mackie, entomologist of the Department of Agriculture, was in charge. He had the very best power sprayers and equipment at his command. By March 5th, twelve blocks at Yuba City and Marysville had been sprayed and about one hundred and forty trees completely destroyed at the request of the owners. A check of the results showed from 97% to 99% control.[238]

In May a small infestation was found at Gridley, Butte County, and promptly sprayed.

A thorough inspection during the summer and fall of all infested districts showed a marked decrease in the numbers of the pests. A general inspection of all contiguous districts resulted in the finding of the pest at Oroville, where for years it had been confidently believed to have been eradicated in 1907–1908, and where repeated inspections during subsequent years had failed to reveal its presence.

In February, 1928, a cape jasmine plant was discovered at Ontario, California, infested with the citrus white fly. It had been received from Florida by mail, and not having been legally marked " plants " it escaped interception. However, the plant had been defoliated before shipment and also found after it had been planted before any of the young white flies had matured, so it is likely that

[236] *Ibid.*, vol. 15, pp. 114–115 (1926).
[237] Hardison, A. C., *The status of the white fly campaign*, *ibid.*, vol. 16, pp. 132–134 (1927).
[238] *Pacific Rural Press*, vol. 113, p. 311 (March 5, 1927).
Wood, W. R., *Efficient white fly control*, Calif. Cultivator, vol. 70, p. 222 (Feb. 25, 1928).

this small colony was entirely eradicated with the burning of the infested plant. To make sure of this the State Department of Agriculture sprayed all surrounding shrubbery and trees which were liable to have been infested.[239]

In April, 1928, the citrus white fly was located in a nursery at Arcadia, Los Angeles County, and subsequent inspection revealed five additional centers of infestation.[240] In two cases adults had not yet emerged and the destruction of all the infested host plants promised eradication; in the other cases adults had already emerged so that in addition to the destruction of all infested hosts, an extensive spraying treatment was given to all adjoining hosts. This program is to be continued until no further insects are to be found.

LYGÆIDÆ (Family). Chinch Bugs.

The chinch bug, *Blissus leucopterus* (Say), was collected in California by some students of Johns Hopkins University in 1884, but a single specimen being taken. In 1885 Albert Kœbele collected a large series of specimens at Alameda.[241] Since that time this insect has been taken in few numbers, but has never been sufficiently abundant to be a pest in any case that is recorded.

COLEOPTERA (Order)

Beetles and Weevils

ŒDEMERIDÆ (Family).

Nacerda melanura (Linn.) (*Nacerdes*) is an œdemerid beetle of cosmopolitan distribution described by Linnæus in 1758.[242] It has received some recognition in Europe as an economic insect.[243] It is primarily a maritime species now known to occur in Europe, Siberia, Australia, Japan, and the United States. In the United States it is reported from Indiana (Leng), Maryland (Böving), and California (Essig). The larvæ usually attack coniferous wood that is permanently or often wet and are chiefly found in piles or timbers used in wharves, bulkheads, etc.

[239] *Calif. Cultivator*, vol. 70, p. 229 (Feb. 25, 1928).
[240] Ryan, H. J., Calif. State Dept. Agr., *Mthly Bul.*, vol. 17, p. 376 (1928).
[241] *Insect Life*, vol. 1, p. 26 (1885).
[242] *Systema Naturæ*, ed. 10, p. 403 (1758).
[243] Boas, J. E. V., *Dansk forstzoologi*, pp. 264–267 (1923). Centrabl. d. Bauverwallung, pp. 55–56 (1891).

Larvæ of this beetle were first received by me from H. R. Lacy, San Diego, Calif., in May, 1928. They were taken from a damp Douglas fir mud sill, 18 years old and one foot above high tide in the wharf at the Destroyer Base at the foot of Broadway. They were determined by A. G. Böving, U. S. National Museum.

On May 10, 1929, another lot of larvæ were taken from a wet and partly decayed Douglas fir timber in the wharf of the Western Sugar Refinery at the foot of 23rd Street, San Francisco. In both cases the attacks were limited to wet sound or wet decayed coniferous wood. Böving states that it has also been recorded in oak timber.

BUPRESTIDÆ (Family). Metallic Wood Borers.

The western flat-headed borer, *Chrysobothris mali* Horn, long masked under the name of the common eastern species, *C. femorata* Olivier, although both occur in the state. The former was first recorded indigenous in 1855 by P. S. Strentzel [244] although it was not described by G. H. Horn until 1886 when he had before him specimens collected by L. E. Ricksecker in California and reported as " infecting apple trees." [245] Some of the specimens described by Horn also came from Owens Valley. In 1878 it was noted in Ventura County.[246] The confusion between this species and the common eastern form was completely cleared up by H. E. Burke in 1917 [247] and 1919.[248]

BOSTRICHIDÆ (Family). Branch and Twig Borers.

The branch and twig borer, *Polycaon confertus* Lec., was first reported attacking grape canes in Napa County in 1872. Dusting with sulfur was suggested as a remedy.[249] It was next reported attacking olive twigs in Sonoma County in 1877 by G. P. Rixford.[250] It became fairly well known by 1881 and in 1882, Felix Gillet, State Horticultural Commissioner in Eldorado County, was first to state that this insect normally attacks oaks. Injury to

[244] *California Farmer*, vol. 4, p. 84 (Sept. 14, 1855).
[245] *Trans. Am. Entom. Soc.*, vol. 13, p. 97 (1886).
[246] *Pacific Rural Press*, vol. 15, p. 147 (March 9, 1878).
[247] *Jour. Econ. Entom.*, vol. 10, p. 328 (1917).
[248] *Ibid.*, vol. 12, pp. 326–330 (1919).
[249] *Pacific Rural Press*, vol. 3, p. 264 (April 27, 1872).
[250] *Ibid.*, vol. 13, p. 376 (June 16, 1877).

fruit trees by this borer continues unabated but at no time has it been of a really serious nature.

CERAMBYCIDÆ (Family). Long-Horned Borers.

The California prionus, *Prionus californicus* Mots. (Fig. 21), is one of the most interesting beetles in California, but causes little serious injury. It was collected probably in the vicinity of Fort

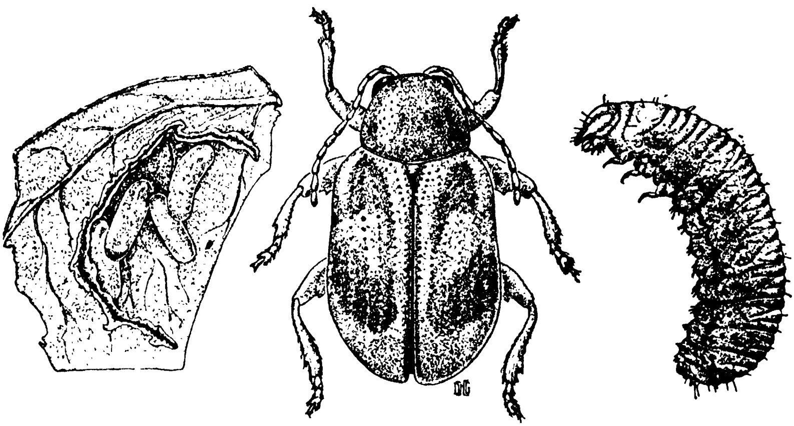

FIG. 66.—The strawberry root worm, *Paria canella* (Fabr.), is a North American insect having a number of color varietal forms. The one in the West is *quadrinotata* (Say). × 10. (Eggs and larva redrawn from C. A. Weigel, U. S. D. A., 1926.)

Ross by I. G. Vosnesensky in 1840 and described by T. V. von Motschulsky in 1845. H. H. Behr refers to it as attacking walnut trees in 1879.[251] Matthew Cooke wrongly describes it as *Prionus laticollis* (Drury) and refers to it as "hollowing out the roots of apple trees, grape and hop vines." [252] A related species, the pine sawyer, *Ergates spiculatus* Leconte, was described in 1852. The larvæ were taken from Douglas fir by H. Gibbons, Jr., on March 21, 1870.[253]

CHRYSOMELIDÆ (Family). Leaf Beetles.

The strawberry root worm, *Paria canella* (Fabricius) (Figs. 66–67), is an American insect which was originally named *Cryp-*

[251] *Pacific Rural Press*, vol. 18, p. 89 (Aug. 9, 1879).
[252] *Injurious insects of the orchard, vineyard, etc.*, pp. 169–171 (1883).
[253] *Proc. Calif. Acad. Sci.*, vol. 4, p. 117 (1873).

tocephalus canellus by Fabricius [254] in 1801. Since then the species has been placed in the genera *Eumolpus*,[255] *Paria*,[256] and *Typophorus*.[257] According to Weigel [258] the injurious forms of this beetle fall into two varieties: *Paria canella* (Fabr.) var. *quadrinotata* (Say) [259] and *Paria canella* (Fabr.) var. *gilvipes* (Horn).[260]

As an economic insect this beetle has a comparatively modern history. Cook [261] appears to have first recorded it as a pest of strawberries in Michigan in 1881. Forbes [262] noted it attacking wild crab apple, cinquefoil, juniper, raspberry, and strawberry in Illinois in 1884. Webster [263] recorded it on blackberry and raspberry in Ohio in 1893. Fletcher [264] first observed it in Canada on raspberry in 1894. Harvey [265] noted it on the same host in Maine in 1895. In 1906 Felt [266] recorded it in New York on aster, butternut, mountain ash, and strawberry. Swenk [267] reported injury to apple trees in Nebraska in 1908–1909. Blatchley [268] listed several varieties from Indiana on wild grape, horseweed, juniper, and redbud in 1910. In 1916 Cory [269] was the first to record it as a pest of roses in greenhouses. Since then it has become conspicuous in this rôle particularly in Maryland, New Jersey, and Pennsylvania through the investigations and writings of Weigel, Chambers, Doucette, and Peterson.[270] Weigel added the following hosts: grapes, millet

[254] Fabricius, J. C., *Systema Eleutheratorum*, vol. 2, p. 52 (1801).

[255] Olivier, G. A., *Entomologie, ou histoire naturelle des insectes, etc.*, vol. 6, p. 915, pl. 2, fig. 3 (1808).

[256] LeConte, J. L., *Proc. Acad. Nat. Sci.*, Philadelphia, vol. 10, p. 86 (1858).

[257] Horn, G. H., *Trans. Am. Entom. Soc.*, vol. 19, pp. 207–208 (1892).

[258] Weigel, C. A., *The strawberry rootworm a new pest on greenhouse roses*, U. S. Dept. Agr., Bul. 1357, pp. 2–3 (1926).

[259] *Colaspis quadrinotata* Say, *Jour. Acad. Nat. Sci.*, Philad., vol. 3, p. 446 (1824).

[260] *Typophorus canellus* (Fabr.), var. *gilvipes* Horn, *Trans. Am. Entom. Soc.*, vol. 19, p. 208 (1892). Horn also listed the varieties *sexnotatus* and *aterrimus* and the sub-variety *aterrimus* as well as many others.

[261] Cook, A. J., *A new insect enemy*, 10th Ann. Rept. Secy. State Hort. Soc., Mich., 1880, pp. 293–295 (1881).

[262] Forbes, S. A., *Insects injurious to the strawberry*, 13th Ann. Rept. State Entom., Ill., 1883, pp. 159, 163 (1884).

[263] Webster, F. M., *Insects affecting blackberry and raspberry*, Ohio Agr. Exp. Sta., Bul. 45, p. 202 (1893).

[264] Fletcher, James, Entom. Soc. Ontario, *25th Ann. Rept.*, 1894, p. 81 (1894).

[265] Harvey, F. L., *The spotted Paria, Strawberry leaf weevil*, Maine Agr. Exp. Sta., Ann. Rept., 1895, pp. 106–110, fig. 6 (1896).

[266] Felt, E. P., *Insects affecting park and woodland trees*, N. Y. State Mus., Mem. 8, vol. 2, pp. 508, 537, fig. 135 (1906).

[267] Swenk, M. H., *The principal insects injurious to horticulture during 1908–1909*, Nebr. State Hort. Soc., 40th Ann. Rept., p. 83, pl. 3, b (1909).

[268] Blatchley, W. S., *Coleoptera of Indiana*, pp. 1139–1140, fig. 490 (1910).

[269] Cory, E. N., Md. Agr. Soc., *Rept.*, 1916, vol. 1, p. 206, figs. (1917).

[270] Weigel, C. A., and Chambers, E. L., *The strawberry rootworm injuring roses in greenhouses*, Jour. Econ. Entom., vol. 13, pp. 226–232 (1920).

heads, oats, peach, and rye. As a result a renewed interest in the East was taken in this insect. In 1921 Britton [271] recorded an infestation on Japanese walnut in Connecticut, and it was noted as a pest of strawberries in New York [272] and in Wisconsin. [273] In 1922 it was reported from Massachusetts [274] and Louisiana. [275] In 1923 additional reports came from New York [276] where considerable injury to strawberries was noted. In May, 1927, it was reported from Birmingham, Alabama,[277] in January, 1928, from Tupelo, Mississippi,[278] and in August, 1929, from Ohio.[279]

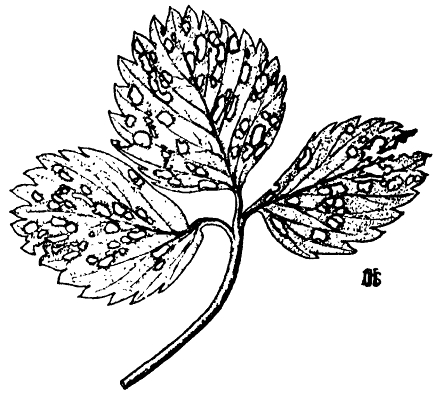

FIG. 67.—Strawberry leaf showing the characteristic small holes eaten out by the adults of the strawberry root worm, *Paria canella* (Fabr.). The larvæ attack the roots. Natural size.

In California this insect [280] appears to have been first collected in the San Francisco Bay region by E. C. Van Dyke in 1905. The writer first noted its injury to strawberry plants in commercial patches at Elk Grove, August 2, 1917. It was again observed seriously injuring Banner strawberry plants in commercial plantings at May-

Weigel, C. A., and Doucette, C. F., *Further observations on the strawberry root worm on roses*, *ibid.*, vol. 15, pp. 204–209 (1922).

Control of the strawberry rootworm in commercial rosehouses, *ibid.*, vol. 16, pp. 283–288 (1923).

The strawberry rootworm as an enemy of the greenhouse rose, U. S. Dept. Agr., Farmers' Bul. 1344, 14 pp., 14 figs. (1923).

Weigel, C. A., *The strawberry rootworm, a new pest on greenhouse roses*, *ibid.*, Bul. 1357, 48 pp., 16 figs. (1926). Bibliography.

Peterson, A., *The strawberry root-worm, serious pest on roses in the greenhouse*, N. J. Agr. Exp. Sta., Rept., 1919–1920, pp. 468–493, 1 fig., 3 pls., 6 tables (1922).

[271] Britton, W. E., *21st Rept. State Entom.*, Conn., 1921, Conn. Agr. Exp. Sta., Bul. 234, p. 195 (1922).

[272] U. S. Dept. Agr., Bur. Entom., *Insect Pest Surv. Bul.*, vol. 1, p. 68 (1921).

[273] Fracker, S. B., *ibid.*, p. 237 (1921).

[274] Weigel, C. A., *ibid.*, vol. 2, p. 26 (1922).

[275] Jones, T. H., *ibid.*, p. 53 (1922).

[276] Waggoner, C. C., Rupert, P. D., *ibid.*, vol. 3, pp. 82, 140 (1923).

[277] Johnson, N. B., *ibid.*, vol. 7, p. 161 (1927).

[278] Harned, R. W., *ibid.*, vol. 8, p. 22 (1928) (*Paria canella* var. near *gilvipes* Horn).

[279] Mendenhall, E. W., *ibid.*, vol. 9, p. 335 (1929).

[280] The variety in California is *quadrinotata* (Say).

field, August 12, 1920, when larvæ were also noted on the roots. In the adjacent fields the adults were also feeding on the leaves of raspberries and blackberries. In September 3d of the same year I also noted severe injury to strawberries by the larvæ and adults at Irvington. Adults were reported feeding on potato plants at Sacramento, October 11, 1921. In 1921 also Smith [281] recorded an abundance of the beetles in strawberry fields at Florin, and Urbahns [282] gave a good account of the insect in California. The distribution included widely separated areas in the Sacramento, San Joaquin and Santa Clara valleys, estimated at about 300 acres. In this same year the writer had either noted it in, or received specimens from, San Francisco, San Mateo, Santa Clara, Alameda, Contra Costa, Santa Cruz, San Joaquin, and Sacramento counties. This area remains about the same today, with, however, a greater distribution of the insect within the different counties. The attacks of the beetle on berries is sporadic and severe in isolated patches. It does not appear to be able to lay waste a whole district, but rather to kill out small definite areas in a patch.

The strawberry root worm is also recorded in Arizona and New Mexico.[283]

The elm leaf beetle, *Galerucella luteola* (Müller),[284] a European

[281] Smith, H. S., *ibid.*, vol. 1, p. 30 (1921).

[282] Urbahns, T. D., *The strawberry rootworm* (Paria canella), Calif. State Dept. Agr., Mthly. Bul., vol. 10, pp. 311–313, figs. 48–50 (1921).

[283] Essig, E. O., *Insects of Western North America*, p. 468 (1926).

[284] This beetle has also been described as *G. xanthomelæna* (Schrank), *G. calmariensis* (Fabr.), *G. cratægi* (Joann.), *G. gelatinariæ* (Fabr.), and *G. ulmi* (Geoffr.). Concerning the proper taxonomy of this insect H. S. Barber (Jan. 25, 1930) through H. Morrison has furnished the following information at my request: "With only our poor and very inadequate European samples of what are supposed to be the elm leaf beetle of this country, I cannot properly judge either the nomenclature or the taxonomy of the species. But I am impressed by a discrepancy between our specimens and the original description by Müller, in which he described the pronotum as 'thorax bipunctate—one spot on each side,' whereas all of our specimens have a median as well as the lateral discal black marks, and are obviously tripunctate. With all respect due to the European taxonomists who have produced the late catalogues, I feel that *Chrysomela luteola* Müller 1766 may have been misidentified and that some species other than our elm leaf beetle, indigenous in Turin, may have been first given this name. But I have not attempted to read much of the literature on the species and do not know if Weise 1924 (Junk Catalogue, Part 78, p. 57) properly shows who revived the name *luteola* and applied it to our elm pest. From the citations there given, it appears that Bedel 1897 was the one, but his paper merely includes *luteola* Müll. in his table of species of *Galerucella*, and offers no explanation or synonymy except that a very short introductory paragraph includes a statement that *G. luteola* attacks the *Ulmus*. In spite of these doubts, I think it best to continue using the name *Galerucella luteola* (Müll.), for our elm pest until a careful examination of the real status of the several names can be made on both zoölogical and nomenclatorial grounds.

insect, was described as *Chrysomela luteola* by Müller[285] in 1766 from specimens collected in Turin, Italy.[286] Since then it has been reported as a pest of elms throughout Europe, in Asia (Astrachan, Turkestan, and Siberia), in Africa (Algeria), and in many parts of North America.

It was introduced into the United States sometime previous to 1837 (about 1834), for according to Harris,[287] it was seriously injuring elm trees near Baltimore, Maryland, in 1838 and 1839. Glover,[288] fully described the insect, its work and control in 1867. This early study was followed by many articles in the agricultural press of the day and in the few entomological journals. Riley [289] has given us the best early accounts of the insect in the United States. Very splendid reports have also been made by many other entomologists [290] since.

"The enclosed copy of the original description will give you the original generic assignment of the species and, if we correctly understand the title of the paper in which it occurs, will indicate the 'type' locality as Turin, Italy."

[285] Müller, O. F., *Manipulus insectorum Taurinensium a corola allionio editus*, Mélanges Soc. Roy. Turin, vol. 3, p. 187 (1776). The original description is as follows·

"*Chrysomela*

. . . .

luteola, oblonga, lutea: thorace bipunctato: elytris fascia longitudinali nigra.

Caput, thorax, elytra, pedes lutei; in fronte duo puncta, in thorace utrinque unum, in quovis elytro fascia lata, nigra. Oculi et antennæ fusca. Abdomen nigrum, puncta duo obsoleta basim elytrorum versus."

[286] Silvestri, F., *Contribuzioni alla conoscenza degli insetti dannosi e dei loro simbionti*. I. Galerucella dell' olmo. (*Galerucella luteola* F. Mull.), Ann. R. Scuola sup. Agric. Portici (2), vol. 9, no. 11, 46 pp., 25 figs. (1910).

[287] Harris, T. W., *Insects injurious to vegetation*, p. 124 (1841).

[288] Glover, T., *Rept. Entom.*, Rept. Commr. Agr., 1867, pp. 62–63 (1868).

[289] Riley, C. V., *Am. Entom.*, vol. 3, pp. 291–292 (1880).

The imported elm leaf-beetle, Rept. Entom., Rept. Commr. Agr., 1883, pp. 159–170, pl. xii, fig. 3 (1883); U. S. Dept. Agr., Div. Entom., Bul. 6, 18 pp., fig. 1, pl. I (1885); ed. 2, 21 pp. (1891); Bul. 10, pp. 8–22, figs. 1–6 (1887).

[290] Lintner, J. A., *5th Rept. State Entom.*, N. Y., pp. 234–242 (1889); *11th Rept.*, pp. 189–196 (1895); *12th Rept.*, pp. 253–264 (1896); *15th Ann. Rept.*, N. Y. State Mus., 1896, pp. 253–264, 1 fig., 1 pl. (1898).

Felt, E. P., *Elm-leaf beetle in New York*, Bul. N. Y. State Mus., vol. 5, no. 20, 43 pp., 5 pls. (1898).

Elm leaf beetle in New York State, *ibid.*, no. 57, 56th Ann. Rept., N. Y. State Mus., vol. 3, 43 pp., 2 figs., 8 pls. (1 col.) (1902).

Insects affecting park and woodland trees, N. Y. State Mus., Mem. 8, vol. 1, pp. 105, 146–155, pls. 8 (col.), 35–37 (1905). Bul. 156, pp. 6–14, pl. I (col.), III–V (Jan. 15, 1912).

Howard, L. O., U. S. Dept. Agr., *Farmers' Bul. 99*, pp. 9–14, fig. 3 (1899).

Marlatt, C. L., *The imported elm leaf-beetle*, U. S. Dept. Agr., Div. Entom., Circ. 8, 2d ser., 4 pp., 1 fig. (May 23, 1895), revised, 6 pp. (Aug. 31, 1908).

Although introduced into this country at an early date this insect has been comparatively slow in distribution. It soon appeared in the upper Austral zone of the Atlantic States, from Maine to North Carolina, but its westward progress was slow. Garman [291] noted it first in Kentucky, June 20, 1898. It was reported in Clark County, Ohio, in 1924,[292] having previously been known at Dayton, Ohio. Pettit [293] also reported it from Monroe, Michigan, in the same year.

In Oregon the elm leaf beetle was reported by Lovett [294] at Salem, Marion County, and Corvallis, Benton County, on May 10, 1921, it having previously been known to occur in Multnomah County. Rockwood,[295] reported it from Garden Grove, Washington County, the same year. It became abundant in the Willamette Valley in 1922.[296] It was reported from Chelahis, Washington, Sept. 17, 1923, by Melander,[297] who knew of its previous existence at Vancouver and Clarkston along the Columbia River.

On August 3, 1924, it was found abundant in Fresno, California, by Urbahns,[298] which is the first record of the insect in this state. An inspection of the city showed 80 blacks to be infested on Sept. 6, 1924. In spite of a vigorous spraying campaign the natural spread and the artificial spread by automobiles, which parked under the infested elm trees, was very rapid so that by the end of the year it was known to occur at Fresno, Selma, Kingsburg, Orosi, Sultana, Dinuba, Reedley, Sanger, Sunnyside, Clovis, and Visalia. By

Garman, H., *The elms and their diseases*, Ky. Agr. Exp. Sta., Bul. 84, pp. 65–72 (1899).

Fernald, H. T., *The imported elm leaf-beetle*, Hatch Agr. Exp. Sta., Bul. 76, 8 pp., 1 fig. (1901).

Britton, W. E., *The elm leaf beetle*, Conn. Agr. Exp. Sta., Bul. 155, 15 pp., 8 figs. (1907), revised (1909).

Herrick, G. W., *The elm leaf-beetle*, Cornell Agr. Expt. Sta., Circ. 8, 6 pp., 9 figs. (1910). *Ibid.*, Bul. 333, pp. 491–506, figs. 164–176 (1913).

Blackman, M. W., and Ellis, W. O., *Some insect enemies of shade trees and ornamental shrubs*, Bul. N. Y. State College of Forestry, vol. 16, pp. 37–41, pl. II (col.) (1916).

Kotinsky, J., *Insects injurious to deciduous shade trees and their control*, U. S. Dept. Agr., Farmers' Bul. 1169, pp. 38–39, fig. 21 (1921).

Pettit, R. H., *The elm leaf beetle*, Mich. Agr. Exp. Sta., Quart. Bul., vol. 7, pp. 20–21, 1 fig. (1924).

[291] Garman, H., *op. cit.*, p. 65.

[292] Mendenhall, E. W., U. S. Dept. Agr., Bur. Entom., *Insect Pest Surv. Bul.*, vol. 4, p. 195 (1924).

[293] Pettit, R. H., *ibid.*, pp. 195, 245 (1924).

[294] Lovett, A. L., *ibid.*, vol. 1, pp. 73, 179 (1921).

[295] Rockwood, L. P., *ibid.*, vol. 1, p. 216 (1921).

[296] Lovett, A. L., *ibid.*, vol. 2, pp. 95, 142 (1922).

[297] Melander, A. L., *ibid.*, vol. 3, p. 300 (1923).

[298] Urbahns, T. D., *ibid.*, vol. 4, p. 246 (1924).

August, 1925, all of the infested elm trees in Fresno County which were not sprayed with arsenate of lead, were completely defoliated. In 1926 it was in Bakersfield (Fig. 68) and in Hanford and throughout much of the San Joaquin Valley, being serious in Fresno, Tulare, Kern, and Kings counties. In 1928 it had reached Roseville and Hornbrook, on the north, but had skipped many localities on the way. In 1930 F. H. Wymore received specimens from Hornbrook and Sacramento. At the present time the exact distribution in California [299] is unknown, but it is only a matter of time until all the elms are infested.

FIG. 68.—Large elm tree, growing along the California state highway twelve miles south of Bakersfield, completely defoliated by the elm leaf beetle. Although this beetle was first observed in the United States in Maryland in 1838, ninety years were required for it to cross the continent. (Photograph taken June 15, 1928.)

The possible introduction into the United States of the egg parasite, *Tetrastichus xanthomelænæ* (Rondani), of the elm leaf beetle was investigated by Howard [300] on his visits to France

[299] Essig, E. O., *Insects of Western North America*, p. 473, fig. 381 (1926).
Mackie, D. B., Calif. State Dept. Agr., *Mthly. Bul.*, vol. 16, pp. 294–301, figs. 64–67 (1927).
Burtch, L. A., *ibid.*, vol. 18, pp. 327, 426 (1929).

[300] Howard, L. O., *The importation of* Tetrastichus xanthomelænæ (*Rond.*), Jour. Econ. Entom., vol. 1, pp. 281–289, fig. 7 (1908).

in June, 1905, and again in May, 1907. As a result of a request for this parasite he received parasitized eggs of the elm leaf beetle from Valerie Mayet, Montpellier, France, about May 28, 1908. These were forwarded to W. F. Fiske at Melrose Highlands, Massachusetts, where the parasites were reared and liberated at two localities; 600 adults at Cambridge, June 22, and 1,200 adults at Melrose Highlands, near Boston, and parasitized eggs were sent to J. B. Smith, New Brunswick, New Jersey, and to M. V. Slingerland, Ithaca, New York, and to Washington, D. C. As no adults were ever recovered from these liberations it was inferred that the parasite never became established and a second attempt was made to introduce and establish the insect by Howard [301] in 1917. On June 25th he received from F. Picard, Montpellier, France, another lot of parasitized eggs of the elm leaf beetle. The adult parasites first reared from this material were liberated by J. Kotinsky near the Andorra Nurseries, Chestnut Hill, Philadelphia, some others were sent to R. Matheson, Ithaca, and a few were released on elm trees at 1914 Sixteenth Street, Washington, D. C., on July 19.

In 1926 another lot of this parasite was also introduced and liberated.

The tachina parasite, *Erynnia nitida* R. D., was received from W. R. Thompson, Hyeres, France, in March, 1925, and liberated in Virginia.[302]

The western twelve-spotted cucumber beetle, *Diabrotica soror* Leconte, has long been an ever-present nuisance and pest to flowers, vegetables, and field crops in California. This beetle was first collected in California by J. F. Eschscholtz in 1824 and again by Tschernikh in 1833–1835. It was wrongly determined by Russian entomologists as *Diabrotica duodecempunctata* (Fabr.). That it became evident from the very beginnings of agriculture cannot be doubted. However, no records concerning it appear until 1879 [303] when it is reported as injuring fruit and plants in Alameda, San Joaquin, and Colusa counties. In 1897 R. W. Doane worked out the life history of this beetle in the West [304] and a few other observations have been made and published since that time.[305]

[301] Howard, L. O., *ibid.*, vol. 10, pp. 504–505 (1917).
[302] U. S. Dept. Agr., Bur. Entom., *Insect Pest Surv. Bul.*, vol. 5, p. 81 (1925).
[303] *Pacific Rural Press*, vol. 17, p. 392 (June 14, 1879).
[304] *Jour. N. Y. Entom. Soc.*, vol. 5, pp. 15–17 (1897).
[305] Essig, E. O., *U. C. Jour. Agr.*, vol. 3, pp. 12–15 (1915).

CURCULIONIDÆ (Family). Weevils.

Fuller's rose weevil, *Pantomorus godmani* (Crotch) (Figs. 69, 70), was originally collected by Crotch on brambles at Fayal on the island of Horta, Azores, in 1866 and described as *Asynonychus godmani.*[306] It received little attention until after it was discovered in many parts of the United States from New Jersey to Montana and described as *Aramigus fulleri* Horn [307] in 1876. As the first specimens were received from A. S. Fuller of Montana in 1875, it was named for him and has since gone under the common name designated above. It was only found in greenhouses there and throughout the eastern states indicating that it was introduced from warmer regions.

According to Schwarz, [308] " A single specimen, found at Cambridge, Mass., by the late Mr. Edward Burgess, is in Mr. Henshaw's collection, but in 1875 and subsequent years it suddenly made its appearance at many widely distant localities in North America. On the Atlantic slope it occurred usually in greenhouses, rarely outdoors, from Massachusetts to Georgia, being evidently transported from place to place by nursery stock, but since a number of years it has entirely disappeared, except at some isolated localities in the South. In Canada it appeared likewise in greenhouses, and was still present in 1890. In California it occurred outdoors, and was still present in 1892. The species does not belong to the fauna of the Atlantic slope, nor to the Pacific fauna, but since it is evidently an American insect its original home is, in all probability, the central region where allied species and genera occur."

J. A. Lintner reports to have first noted this weevil injurious to camellias and other plants in greenhouses in Albany, New York, in 1874.[309]

Peter Henderson [310] was one of the first to call attention to its economic aspects since he had received complaints regarding it from rose growers in six different states. C. V. Riley published the first complete articles regarding it the same year,[311] he having re-

[306] *Proc. Zoöl. Soc. London*, pp. 388, 389, pl. 23, fig. 9 (1867).
[307] Horn, G. H., *Proc. Am. Philos. Soc.*, vol. 15, pp. 94, 95 (1876).
[308] Schwarz, E. A., *Proc. Entom. Soc. Washington*, vol. 3, p. 145 (1894).
[309] Chittenden, F. H., U. S. Dept. Agr., Div. Entom., *Bul. 27*, n. s., p. 92 (1901).
[310] *Gardeners' Mthly.*, pp. 86, 87 (March, 1879).
[311] *Gardeners' Mthly.*, pp. 310, 311 (October, 1879).
Scientific Am., p. 129, fig. (August 30, 1879).
U. S. Dept. Agr., *Rept.*, *1878*, pp. 255–257, pl. 7, fig. 2 (1879).

ceived much information from Henderson and was the first to describe and figure the various stages of the beetle.

On December 13, 1879, J. H. Comstock [312] received specimens from San Diego, California, collected by J. M. Asher from dracænas, palms, oranges, cape jasmine, and achyrantes. In 1889,

FIG. 69.—Fuller's rose weevil, *Pantomorus godmani* (Crotch), long went by the scientific name, *Aramigus fulleri* Horn. It appears to be a subtropical and introduced species. So far we have always collected it in cultivated areas and never in strictly wild conditions in California. (Photograph from specimens collected at Santa Paula, California, 1914.)

D. W. Coquillett found it injurious to the foliage of live oaks, camellias, palms, cannas and other plants.[313] It was then mistaken for the plum curculio which was thus wrongly reported to have

[312] U. S. Dept. Agr., *Rept., 1879*, pp. 250–251 (1880).
Pacific Rural Press, vol. 19, p. 24 (Jan. 10, 1880).
[313] *Insect Life*, vol. 2, p. 90 (1889).

been established in California. The beetle was described and figured in the Annual Report of the California State Board of Horticulture for 1889 [314] but no information regarding distribution was given. It was again reported injurious in orchards and gardens in California by E. J. Wickson in 1889,[315] and to oranges in National City, California, by D. A. Horton, September 10, 1896.[316]

In this year also Alexander Craw reported that "Fuller's rose beetle has been known all over the state for over twenty years, but was never considered a serious pest," [317] in which year, however, it was quite troublesome in southern California.

In 1901 Chittenden [318] summarized the status of this beetle in North America as follows:

Distribution—Bucksport, Maine; Cambridge, Boston, Worcester, Massachusetts; New York, Rochester, Little Falls, Poughkeepsie, Albany, Long Island, New York; Madison, Summit, Jersey City, Union County, New Jersey; Baraboo, Wisconsin; Mt. Airy, Griffin, Georgia; Sandwich, Illinois; Montana; National City, San Francisco, San Diego, Los Angeles, Fullerton, California; Brantford, Stewarton, Ottawa, Canada; and Hawaii.

In 1903 Frederick Maskew, Horticultural Inspector of Los Angeles County, made some observations and experiments on this insect in southern California which were published in 1904.[319] The larvæ of the weevil were at that time severely injuring the roots of strawberry, raspberry, and loganberry plants in Los Angeles County. Control was obtained in strawberry fields by the use of carbon disulfide at the rate of $\frac{1}{3}$ oz. per $1\frac{1}{2}$ feet at a cost of 10 cents for 75 feet of row.

Since then this beetle has been a common pest of many kinds of crops in California and notably on citrus trees.[320]

In Butte County it was believed to be an agent in the spreading of citrus blast in the winter of 1920–1921.

At the present time this insect is known to infest a large number

[314] Lelong, B. M., pp. 227–228, fig. 83 (1890).

[315] Chittenden, F. H., *op. cit.*, p. 93 (1901).

[316] *Ibid.*, p. 94.

[317] Calif. State Bd. Hort., *Fifth Bien. Rept.*, 1895–1896, p. 129 (1896).

[318] Chittenden, F. H., U. S. Dept. Agr., Div. Entom., *Bul. 27*, n. s., pp. 88–96 (1901).

[319] *Report on investigations and experiments on Fuller's rose beetle in southern California*, U. S. Dept. Agr., Div. Entom., Bul. 44, pp. 46–50 (1904).

[320] Quayle, H. J., *Citrus fruit insects*, Calif. Agr. Exp. Sta., Bul. 241, p. 499, fig. 61 (1911).

of plants.[321] The adults were specially injurious to raspberry plants near Mountain View, California, in May and June, 1930.

It occurs occasionally in greenhouses throughout the North American continent and outdoors in the southern and southwestern states.

Fuller's rose weevil is now more or less cosmopolitan in distribution. It is believed to be native to tropical America and is

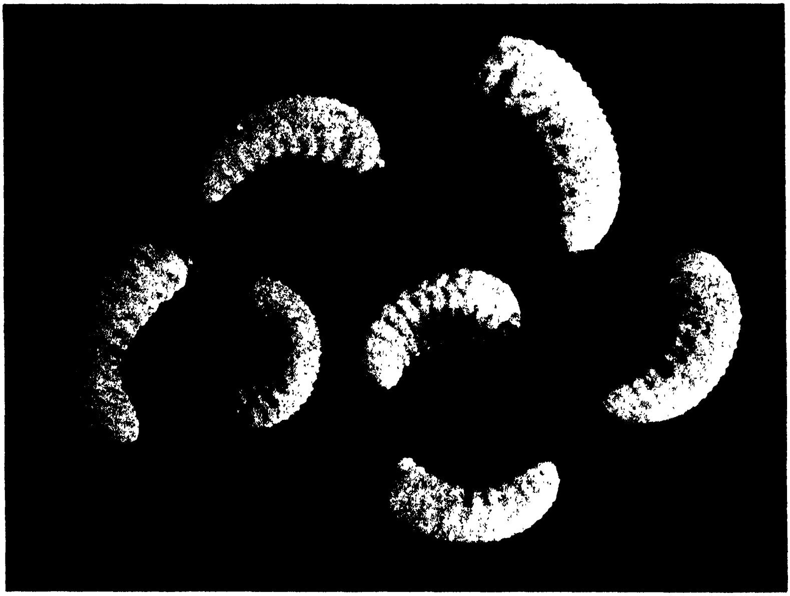

FIG. 70.—Larvæ of Fuller's rose weevil, *Pantomorus godmani* (Crotch), taken from the roots of strawberries, Santa Cruz, December 20, 1926. The larvæ are distinguished from related species by the small, pale-brown heads.

also known in Mexico, Brazil, and Chile and was probably introduced into the other known localities with plant materials. As already noted it reached the Azores prior to 1866. It was first noted in Italy in Liguria, in 1898 [322] and in Sicily in 1908.[323] Perkins

[321] Pierce, W. D., *Jour. Econ. Entom.*, vol. 3, p. 361 (1910).
Essig, E. O., Calif. State Hort. Com., *Injurious and Beneficial Insects of Calif.*, p. 240, fig. 237 (1913), ed. 2, pp. 297–299, fig. 292 (1915).
Insects of W. No. Am., p. 491, fig. 404 (1926).
Lockwood, S., and Keifer, H. H., Calif. State Dept. Agr., *Mthly. Bul.*, vol. 19, pp. 22, 29, figs. 6, 6b, 23 (1929).

[322] Razzauti, A., *Boll. Lab. Zoöl. Agrar. R. Scuola Sup. Agric. Portici*, vol. 7, pp. 113–124, 7 figs. (1913).

[323] *Bul. Soc. Entom. France*, no. 5, pp. 92–93 (1927).

described it from Hawaii in 1900 as *Pantomorus olindæ* [324] and it is commonly known there as the olinda beetle. It has also been taken in Spain, Portugal, the Madeira Islands, and South Africa.

The systematic status of this insect was first definitely established by the Frenchman, A. Hustache,[325] who correctly referred it to *Pantomorus godmani* (Crotch). G. C. Champion, the great English coleopterist, verified the opinions of Hustache in the same year.[326] Thus while the scientific names have undergone complete change the common name remains practically the same as first used in this country.

Present records show this insect to occur outdoors throughout the entire middle and southern parts of California, but in most places it is a pest of only minor importance. As a pest it has probably been more injurious to young citrus nursery stock and to buds and young grafts of the same.

In 1930 Barrett,[327] described and figured the important characters of the larval and pupal forms of this and related weevils and his splendid work now enables us to distinguish the immature stages.

The cribrate weevil, *Brachyrhinus cribricollis* (Gyllenhal), (Fig. 71) was described in the genus *Otiorhynchus* by Gyllenhal in 1834,[328] from specimens taken in middle France. Two varieties have been recognized, *reticollis* Bohemån,[329] described as a distinct species the same year from Sicily, and *terrestris* Mars.

In 1906 Heyden, Reitter, and Weise [330] reported it from France, Hungary, Italy, Dalmatia, and the Balkans. However it was introduced into other parts of the world prior to that time. It was reported injurious to olives in Australia in 1890.[331] In that country it appears to have become quite destructive. In 1914 it was again recorded as an injurious species there in 1912–1913 and again in

[324] Perkins, R. C. L., *Fauna Hawaiiensis, Coleoptera*, vol. 1, p. 130 (1900).
[325] *Bul. Soc. Entom. Fr.*, pp. 100–101 (1922).
[326] *Entom. Mthly. Mag.*, vol. 58 (3) vol. 8, pp. 161–162 (1922). Also see *Biol. Centr.-Am. Coleoptera*, vol. 4, no. 3, p. 333, pl. 15, fig. 19 (1911).
[327] Barrett, R. E., *A study of the immature forms of some Curculionidæ*, Univ. Calif. Pub. Entom., vol. 5, pp. 90–91, figs. 1, 7, 13, 19 (1930).
[328] Gyllenhal, L., in Schoenherr, C. J., *Genera et species Curculionidum*, Tome 2, pt. 2, pp. 582–583 (1834).
[329] Boheman, C. H., *ibid.*, pp. 307–308 (1834).
[330] Heyden, L. V., Reitter, E., and Weise, J., *Cat. Coleopterorum Europæ*, ed. 2, p. 606 (1906).
[331] *Insect Life*, vol. 2, p. 336 (1890).
Kœbele, A., *Rept. of a trip to Australia*, etc., U. S. Dept. Agr., Div. Entom., Bul. 21, p. 12, fig. 4 (1890). It was called the olive snout beetle.

1916.[332] In 1927 it is referred to by Lea [333] as the " most destructive of all plant weevils in South Australia." He gave the following list of host plants: almond, anthirrhinium, apple, apricot, broad bean, French bean, beet, bougainvillæa, carrot, cherry, chrysanthemum, cock's comb, convolvulus, cosmos, dahlia, daphne, dolichos, fig, grape, hawthorn, hibiscus, lemon, lilac, may, mint, mulberry, nectarine, olive, orange, passion vine, pea, peach, pear, plum, potato, quince, radish, sage, strawberry, sunflower, tomato, turnip, verbena, willow. Of these plants the almond, fig, orange, and rose are most injured. The larvæ attack the roots and the adults feed on leaves and bark. On the leaves they often nibble around the edges in a characteristic manner. In 1926 Tillyard [334] stated that this weevil in Australia was " doing more damage to apple trees in some districts than all other insect pests combined."

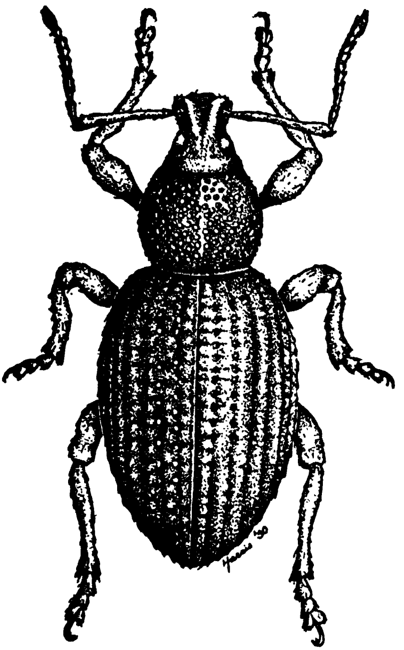

FIG. 71.—The cribrate weevil, *Brachyrhinus cribricollis* (Gyll.), is the latest of the brachyrhinid weevils to be introduced into California. It was discovered in the southern part of the state in 1928. It is a general feeder. × 7½.

The weevil has also been observed injurious to the fruits of olive in Algeria [335] and to orange in Spain.[336]

As is common with many species in this genus, this weevil was

[332] *Jour. Dept. Agr.*, So. Australia, vol. 19, pp. 967–980 (1916).

[333] Lea, A. M., *South Australian plant weevils*, *ibid.*, vol. 30, no. 6, pp. 585–588, fig. 4 (Jan., 1927).

[334] Tillyard, R. J., *The insects of Australia and New Zealand* (Sydney, Angus and Robertson, 1926), p. 242.

Also see Flintoff, A., *Curculio beetle*, Jour. Dept. Agr. Western Aust., vol. 6 (2) pp. 333–339 (1929).

[335] Delassus, *Les insectes ennemis de l'olivier en Algerie*, Rev. agric. Africa Nord., vol. 22, nos. 239–240, pp. 135–139 and 151–155, 6 figs. (Feb. 29 and March 7, 1924).

[336] *Bol. Estación Path. veg.*, vol. 1, no. 3, pp. 107–113 (1926).

found to be parthenogenetic in reproduction by Grandi in 1913.[337]

The history of the discovery of this weevil in California was given to me by H. M. Armitage,[338] Deputy County Horticultural Commissioner of Los Angeles County, as follows:

On October 3rd, 1928, Los Angeles County Agricultural Inspector Robert F. Haymaker, brought in a single adult weevil from Montebello, Calif., taken on the roots of *Viburnum tinus*. Nothing was done with this single insect, however, until June 29th, 1929, when Inspector Arthur Toyne brought in a similar specimen from the same area and found on the roots of *Bolusanthus speciosa*, later determined as *Lonchocarpus speciosus*.

This specimen, together with the original one from the previous year, was forwarded to Dr. Van Dyke for determination. He reports under date of July 5th, that the specimens were a species of *Brachyrhinus*, closely related to the strawberry root weevil, and suggested that they represented a European species new to this country.

On July 17th Mr. R. S. Woglum, sent to this office another specimen of this same insect which he had found on the roots of grass on his lawn in Pasadena.

On July 20th, Inspector H. C. Whitmore, sent in approximately 25 adult specimens from San Fernando Valley, taken around the roots of privet (*Ligustrum ovalifolium*) hedge with the statement that they were very abundant.

Again on August 11th, Mr. H. C. Lewis, brought in a quantity of adult specimens from Pasadena, taken from the roots of privet hedge (*L. ovalifolium*) adjoining the lawn from which Mr. Woglum had sent a previous specimen.

On August 20th we received a definite determination from Dr. Van Dyke to the effect that all specimens submitted represented a species of *Brachyrhinus cribricollis* Gyll.,[339] a native of Southern Europe and new to North America.

From these findings it is evident that this beetle is quite wide-spread over Los Angeles County, at least, and Dr. Van Dyke thinks it of enough importance to warrant careful investigation. Its similarity to the strawberry root weevil and its methods of feeding make it a potential pest.

A few days later Arthur Toyne took a quantity of adults in a nursery in Montebello, directly across the street from the nursery in which it was previously found. The adults seem to be fairly common, averaging about six per plant and were found on *Viburnum sandunkwa*, *Pittosporum tobiera* and *Euonymus japonica*.

In January, 1930, K. L. Wolff [340] published a report on the weevil in southern California and a splendid and complete account of the

[337] Grandi, G., *Un nuovo caso parthenogenesi ciclica irregolare fra i Coleotteri*, Boll. Lab. Zool. gen. agrar. Portici, vol. 7, pp. 17–18 (1913).

[338] By letter dated at Los Angeles, Calif., Sept. 13, 1929.

[339] The specimens were determined by L. L. Buchanan, through E. C. Van Dyke. Ryan, H. J., *New weevil makes its appearance in California*, Calif. State Dept. Agr., Mthly. Bul., vol. 18, p. 567 (1929).

[340] *New weevil under observation*, Calif. Cult., vol. 74, pp. 10–11 (January 4, 1930).

insect was published by Lockwood and Keifer [341] soon afterwards. In April of the same year a horticultural inspector of Sacramento County discovered a veronica hedge in a single nursery in Sacramento, infested with this insect, which is the first record for the northern part of the state.

The strawberry root weevil,[342] *Brachyrhinus ovatus* (Linnæus), (Fig. 72) was described in the genus *Curculio* by Linnæus in 1746.[343] From the first discovery of it in Europe it has received a great amount of systematic and economic discussion and has been known under many different specific names.[344] Because of the great mass of literature no attempt will be made to give more than a scattering bibliography. The insect is apparently well distributed throughout many parts of Europe, particularly the middle and northern portions. One of the more recent important economic references to this insect is by Spessivtseff,[345] who noted a severe infestation of this insect on 3-year spruce seedlings in a nursery in southern Sweden in 1922. Within one year the larvæ killed 400,000 trees by barking the roots.

In North America the strawberry root weevil, as the common name implies, is most injurious as a pest of strawberries and as such appears to have reached the zenith of its powers in the Pacific Northwest. It occurs throughout the northern half of the United States and the southern part of Canada from the Atlantic to the Pacific. In the west it is known from British Columbia to New Mexico. The literature treating this weevil in America is quite extensive and far too voluminous to be included in this brief treatment.

H. F. Wickham is authority for the statement that John Hamilton collected the adults in abundance in a cemetery at Allegheny,

[341] Lockwood, S., and Keifer, H. H., *Preliminary observations on a weevil,* Brachyrhinus cribricollis *(Gyll.), with comparisons to related forms found in California,* Calif. State Dept. Agr., Mthly. Bul., vol. 19, pp. 17–39, figs. 1, 2, 6a, 7a, 7b, 14–18, 19, 25, 26 (1929). Bibliography.

[342] Also known by such common names as the sleepy weevil, pitchy-legged otiorhynchid, strawberry crown girdler, strawberry root girdler, graveyard bug.

It should not be confused with the strawberry weevil, *Anthonomus signatus* Say, a common and serious pest of strawberries throughout the United States east of the Rocky Mountains.

[343] Linnæus, C., *Fauna Scucica, etc.*, p. 626 (1746); ed. 2, p. 626 (1761); Syst. Naturæ, ed. 10, p. 384 (1758).

[344] See Schœnherr, C. J., *Synonymia insectorum, etc.*, pt. 2, p. 631 (1834).

[345] Spessivtseff, Paul, *A contribution to the knowledge of the morphology and biology of* Otiorhynchus ovatus *Linn.*, Meddel. Statens Skogs-Försöksanst, vol. 20, pp. 241–260, 10 figs. (1923).

Pa., in 1875,[346] which was responsible for the common name, graveyard bug. A list of records of the early distribution of this insect in North America is given by R. A. Cooley [347] in 1904 as follows:

Massachusetts, 1852, Henshaw.
Pennsylvania, Allegheny, 1875, Wickham.
Michigan, Detroit, 1878, Wickham.
New Hampshire, Hanover, 1880, Henshaw.
New York, Buffalo, 1882 (?), Wickham.
Michigan, southern, about 1882 or 1883, Weed.
(1883 is correct date).
Canada, Ottawa, 1884, Harrington.
Iowa, Iowa City, not later than 1886, Wickham.
Canada, Nova Scotia, 1889.
Illinois, Chicago, 1889.
Ohio, Wayne County, 1892.
Canada, Quebec, 1892.
Sydney, B. C., 1894.
Indiana, 1892.
Wyoming, Laramie, 1893, Wickham.
New Mexico, Santa Fe, 1894, Wickham.
Minnesota, 1895, Lugger.
Montana, Missoula, 1897, Wilcox.
Washington, Lake Washington, 1904, Melander.
To this list may be added:
Oregon, near Montavilla, 1900, Lovett.
Idaho, Washington County, 1922, Whelan and Wakelund.
Nevada. In quarantine on California border.
California, 1923, Modoc County.
1927, Del Norte County, Urbahns.

A. J. Cook reports having captured it on the grounds of the Michigan Agricultural College, Lansing, before 1868. J. A. Lintner found it abundant in a house in the state of New York in 1878. Clarence M. Weed gave the first full account of the insect and illustrated the larva, pupa, and adult in 1884,[348] it having been discovered injuring strawberry plants on June 8, 1883, by James Troop at Lansing, Michigan. Cook also took it feeding on borage at the same place. Weed suggested the common name, strawberry crown-girdler.

In 1904, Cooley [349] gave a full account of the insect in Montana

[346] *Societas Entomologica*, vol. 9, p. 131 (1894).
[347] Mont. Agr. Expt. Sta., *Bul. 55*, p. 131 (1904).
[348] *The strawberry crown girdler*, Rept. Mich. State Bd. Agr., 1882–1883, pp. 425–429, 3 figs. (1884).
[349] Cooley, R. A., *The strawberry crown-girdler*, Mont. Agr. Expt. Sta., Bul. 55, pp. 130–140, pls. I, II (1904).

and recorded the following host plants: borage, muskmelon, strawberry, currant, roots of bluegrass, apple (?), roots of *Potentilla glandulosa*, roots of *Balsamorrhiza sagittata*, and roots of timothy grass.

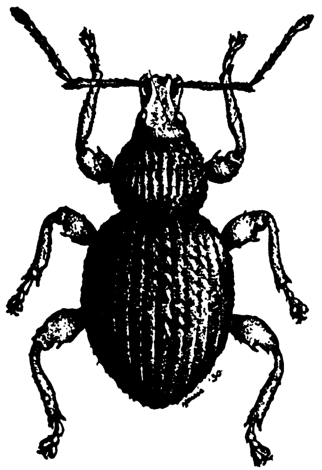

FIG. 72.—The strawberry root weevil, *Brachyrhinus ovatus* (Linn.), is one of the smallest of the injurious brachyrhinids. It is a European insect, first recorded in North America in Pennsylvania in 1875. In the West it was first noted in Oregon in 1900 and in few numbers in the extreme northern part of California in 1927. × 7½.

In 1905, Patch [350] gave a similar treatment of the weevil in Maine. One of the interesting things about the insect there was its habit of entering residences, both in the spring and the fall of the year. In the front room of one house "more than 400 adults were killed."

Fernald [351] noted it injurious to coniferous trees in Massachusetts in 1915. The larvæ were girdling the stems of two-year old white pines in nursery beds as well as red pine, Scotch pine, Virginia juniper, blue spruce, Douglas fir, and sugar maple.

In the Pacific Northwest, where the weevil has been a serious pest of strawberries, much has also been written concerning it.

In British Columbia it was reported as occurring commonly at Sydney in 1894 by Harrington.[352] It became important as a strawberry pest about 1904 and extensive investigations were begun in 1911 relative to its life history, habits and control particularly in the Lower Fraser River Valley. Venebales,[353] Treherne,[354] and Downes [355] have all published important papers concerning it in that region. Besides strawberries, *Rumex acetosella* L., was injured by the larvæ.

[350] Patch, E. M., Maine Agr. Expt. Sta., *Bul. 123*, pp. 205–212, figs. 11–13 (1905).
[351] Fernald, H. T., *28th Rept. Mass. Agr. Expt. Sta.*, Pt. I, pp. 65–68 (Jan., 1916).
[352] Harrington, W. H., Entom. Soc. Ontario, *Rept. 1894*, p. 49.
[353] Venebales, E. P., *Proc. B. C. Entom. Soc.*, pp. 11–16 (1912).
[354] Treherne, R. C., *ibid.*, pp. 41–50 (1912); no. 4, pp. 19–33 (1914).
The strawberry root weevil in British Columbia, Dom. Can. Dept. Agr., Div. Entom., Bul. 8, 44 pp., 7 figs. (1914).
[355] Downes, W., Can. Dept. Agr., *Pamphlet 5*, n. s., 16 pp., 5 figs. (1922); Entom. Soc. Ontario, *53d Ann. Rept.*, pp. 61–64 (1922).
Recent developments in strawberry root weevil control, Jour. Econ. Entom., vol. 20, pp. 695–698 (1927).

It was first noted in Washington at Lake Washington in May, 1904, by Melander,[356] who with Yothers,[357] Spuler,[358] Frank [359] and others, have studied it there and published papers concerning it.

In Oregon, Lovett,[360] states that it was first noted near Montavilla in 1900. In 1908, J. C. Bridwell collected it in the Milton-Freewater district. In 1911 it was abundant only in the "Mt. Tabor, Gresha, Oswego and Russellville district about Portland, and in the Walla Walla Valley in the eastern part of the state," and also at Hood River. In 1927 Mote and Wilcox [361] published a splendid paper on the general biology and control of the three strawberry root weevils in Oregon. The distribution of this species in Oregon then included the counties of Multnomah, Washington, Clackamas, Marion, Linn, Hood River, Wasco, Umatilla, Yamhill, Columbia, Polk, and Coos.

In 1922 Whelan and Wakeland [362] received specimens from Washington County, Idaho, which is the first record from that state.

To prevent the introduction of the three strawberry weevils, *Brachyrhinus ovatus* (Linn.), *B. rugosostriatus* (Goeze), and *B. sulcatus* (Fabr.), into California, where thousands of strawberry plants were yearly shipped from Oregon, the California State Department of Agriculture issued Quarantine Regulation No. 8, November 18, 1920, superseded by Quarantine Regulation No. 9, issued January 21, 1921, which provided that "Each package in each shipment of strawberry plants must bear a certificate signed by a duly authorized representative of the Oregon State Board of Horticulture, stating that the plants have been inspected by a duly authorized inspector, giving date of inspection, and were grown in a district free from strawberry root weevils. Such certificate must give name of grower, name of shipper and locality where grown."

[356] Melander, A. L., *Proc. 13th Ann. Meeting*, Wash. State Hort. Assoc., p. 121 (1917); *Calif. Cult.*, vol. 47, p. 382 (1916).
(With Yothers, M. A.), Wash. Agr. Expt. Sta., *Bul. 136*, pp. 35–42 (1917).
(With Spuler, A.), *ibid.*, *Bul. 199*, 22 pp., 8 figs. (1926).

[357] Yothers, M. A., see Melander, A. L., above.

[358] Spuler, A., see Melander, A. L., above.

[359] Frank, A., Wash. Agr. Expt. Sta., *Bi-Mthly. Bul.*, vol. 10. no. 4, pp. 81–86, 2 figs. (1922).

[360] Lovett, A. L., *Bien. Crop Pest and Hort. Rept.*, 1911–1912, Ore. Agr. Expt. Sta., pp. 122–131, pl. ix (1913).

[361] Mote, Don C., and Wilcox, J., *The strawberry root-weevils and their control in Oregon*, Ore. Agr. Expt. Sta., Circ. 79, 24 pp., 7 figs., 1 pl. (1927).

[362] Whelan, D. B., and Wakeland, C. C., *Outline of Insects of the year* (Mimeographed), p. 18 (1922).

Quarantine Regulation No. 10, issued January 21, 1921, extended the territory to include the State of Washington. In spite of the precautions the strawberry root weevil was taken in a small backyard strawberry patch in Modoc County, California, in 1923.[363] In 1927 infestations of this weevil, as well as of *B. rugosostriatus* (Gœze), were found in Del Norte County,[364] "where considerable damage had taken place in a few fields, although generally berry culture had not been materially hampered by the presence of these weevils."

In 1930 Barrett [365] described and figured the important characters of the larval and pupal stages of this and other important destructive weevils and has thus made it possible to readily distinguish the immature forms.

The rough strawberry weevil, *Brachyrhinus rugosostriatus* (Gœze), (Fig. 73) was originally described in the genus *Otiorhynchus* in 1777 [366] from specimens collected in France.

A historical account of this insect in North America is given by Chittenden [367] as follows:

Several localities in America for this introduced species have been recorded by Pierce, Blatchley and Leng. Quite recently it has made its appearance in the Pacific States in such injurious numbers that attention has been called to it in published articles. As the species is evidently destined to spread as a pest on strawberry, it may be well to relate in brief what is known in regard to its early occurrence in this country. Specimens are available that were collected in the vicinity of New York City by Wilhelm Juelich on September 7, 1891, but there are specimens, also, bearing old-looking labels, from Grand Menen, British Columbia, and Toronto, Ontario, Canada, which would seem to indicate that the species was known at least as early, if not earlier, in those two localities.

In 1906 it was reported by J. F. Fuss as occurring in troublesome numbers in residences in Washington, D. C., and attracted attention at Ithaca, N. Y., in 1907 and in 1910 by its occurrence in numbers in cellars and pantries and elsewhere in dwellings. We next hear of the species, in the records of the Bureau of Entomology, on strawberry at Seattle, Wash., in 1914, and again on strawberry at Washougal, Wash., in 1918. In 1920 it was noted in Alameda County and San Francisco, Calif. Other known localities include Portage, N. Y.,

[363] Calif. State Dept. Agr., *Mthly. Bul.*, vol. 12, p. 360 (1923).
Lockwood, S., and Keifer, H. H., *ibid.*, vol. 19, pp. 21, 29, figs. 4, 10, 11a, 11b, 21 (1929).

[364] *Ibid.*, vol. 16, pp. 540, 654 (1927).

[365] Barrett, R. E., *A study of the immature forms of some Curculionidæ*, Univ. Calif. Pub. Entom., vol. 5, pp. 94–96, figs. 3, 9, 15, 21, 26 (1930).

[366] Gœze, J. A. E., *Entom. Beiträge z. d. Ritter Linné*, vol. 1, p. 395 (1777).

[367] Chittenden, F. H., *Historical notes on* Brachyrhinus rugifrons *Gyll.*, Can. Entom., vol. 57, pp. 290–291, figure of adult (1925).

Newark, N. J., Bethlehem, Pa., Fredericksburg, Va., and Quebec, Canada. Quite obviously, in the writer's opinion, the species reached this country from at least two directions, from Europe and from Asia. Probably it first appeared in Canada and might have been introduced into the United States from there or independently, but the California and Washington introductions are undoubtedly independent of those in the East. The species is as yet unknown in the Central States between Pennsylvania and the Pacific Coast.

Abroad, this species is known to inhabit northern Europe only but it will probably be found in northern Asia. It will be interesting to learn if this pest can become permanently acclimated much farther south than San Francisco, Calif., and if at all in the District of Columbia.

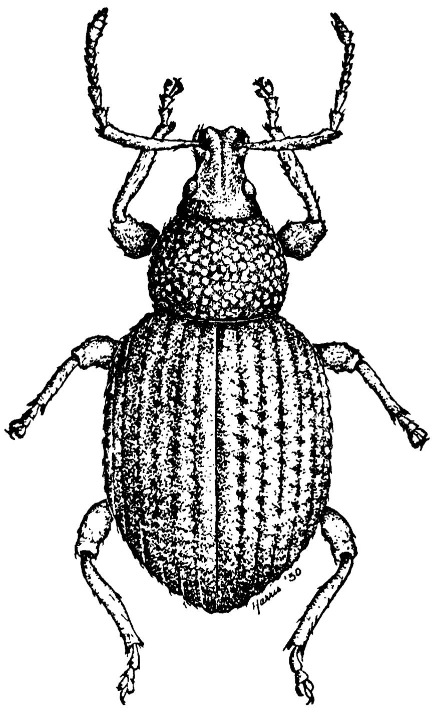

FIG. 73.—The rough strawberry weevil, *Brachyrhinus rugosostriatus* (Gœze), is also of European origin and now occurs in several places in North America. An infestation of this weevil was discovered in a strawberry field at Mt. Eden, California, in May, 1920, and apparently eradicated in 1921. It has been noted since in two different localities in the northern part of the state. × 7½.

The weevil was first reported from Oregon in 1911,[368] and in 1927 was known to occur in Lane and Multnomah counties.[369]

Treherne [370] thought it might also be found in the strawberry fields of British Columbia. Melander and Spuler [371] recognized it as a pest of strawberries and cranberries in Washington prior to 1926.

[368] Wilson, H. F., *Bien. Crop Pest and Hort. Rept.*, Ore. Agr. Expt. Sta., 1911–1912, p. 131 (1912).

[369] Mote, Don C., and Wilcox, J., *The strawberry root weevils and their control in Oregon*, Ore. Agr. College Exp. Sta., Circ. 79, 24 pp. 7 figs., 1 pl. (1927).

[370] Treherne, R. C., Dom. Canada Dept. Agr., Div. Entom., *Entom. Bul. 8*, p. 11 (1914).

[371] Melander, A. L., and Spuler, A., Wash. Agr. Expt. Sta., *Bul. 199*, p. 7 (1926).

In California it was discovered May 12, 1920, in a strawberry patch of about 30 acres near Mt. Eden where by April 1, 1921, it had destroyed 20% of the plants.[372] A campaign of eradication conducted by H. S. Smith, California State Department of Agriculture, in 1921 [373] appears to have been successful as no weevils have been found in the original area since. In 1927 infestations of this weevil were discovered in Del Norte County and near Eureka, Humboldt County.[374] In the former county it was in company with *B. ovatus* (Linn.), where "considerable damage had taken place in a few fields, although generally berry culture had not been materially hampered by the presence of these weevils." In Humboldt County it was accompanied by *B. sulcatus* (Fabr.) both of which "were found quite generally distributed in strawberry, blackberry, raspberry, and loganberry plantings."

In May, 1928, I received adults collected on ornamentals at Watsonville, California, by F. L. Kellogg. On July 10, 1928, L. M. Smith, Division of Entomology, University of California, discovered a large and extensive infestation of this weevil in a raspberry patch at Mountain View, California. Considerable injury was being done to the roots by the larvæ and to the foliage by the adults. Eradication was not attempted, but good results were obtained in reducing the adults with poisoned dried apple pulp which was developed for the control of the strawberry root weevil in Washington.

In August, 1929, Steward Lockwood, entomologist, California State Department of Agriculture, located two infestations of this insect in strawberry patches in Trinity County, California.

G. F. Knowlton reported finding the insect in Utah in 1924.[375]

In 1927, L. L. Buchanan, Bureau of Entomology, worked out the synonymy of this species in America and gives the following important information:[376] "The widely distributed species which is usually listed as *rugifrons* Gyll., and which has recently attracted some attention on the Pacific Coast as a strawberry weevil, proves

[372] Smith, H. S., U. S. Dept. Agr., Bur. Entom., *Insect Pest Surv. Bul.*, vol. 1, p. 30 (1921).
Essig, E. O., *Insects Western No. Am.*, p. 494 (1926).
Lockwood, S., and Keifer, H. H., Calif. State Dept. Agr., *Mthly. Bul.*, vol. 19, pp. 22, 29, figs. 5, 12, 13a, 13b, 22 (1929).
[373] Calif. State Dept. Agr., *Mthly. Bul.*, vol. 10, p. 622 (1921).
[374] *Ibid.*, vol. 16, pp. 542, 654 (1927).
[375] U. S. Dept. Agr., Bur. Entom., *Insect Pest Surv. Bul.*, vol. 4, p. 130 (1924).
[376] *Synonymical notes on several otiorhynchid weevils*, Can Entom., vol. 59, pp. 183–184 (1927).

to be *rugosostriatus* Gœze. The true *rugifrons* seems to be confined to eastern Canada, a series from Sydney, Nova Scotia (1894), in the Canadian National collection being the only North American examples of this species seen; *rugusostriatus*, on the other hand, has a wide distribution, ten states and three Canadian provinces being represented among the 90 specimens examined. A part of this material (from Seattle, Wash., and Salem, Ore.) is labeled as having been reared from strawberry. It is safe to say that practically all of the American records for *rugifrons*, excepting the Nova Scotian one by Harrington,[377] properly refer to *rugosostriatus*." Descriptions of and other references to *rugosostriatus* under the name *rugifrons* can be consulted.[378] Both species are introductions from Europe.

Barrett,[379] in 1930, described and figured the important characters of the larval and pupal stages and has made it possible to readily distinguish the immature forms.

The black vine weevil,[380] *Brachyrhinus sulcatus* (Fabricius), (Fig. 74) [381] was described as *Otiorhynchus sulcatus* by Fabricius in 1775 from middle boreal Europe. It has since gained a wide distribution and appears likely to become the most formidable pest of the four species of *Brachyrhinus* discussed. It has been known as an injurious insect since its discovery and the published records regarding it are too numerous to be included here.

In Europe it is a pest of considerable importance and became especially noted as a pest of grapevines on the Ile d'Oleron on the west coast of central France through the investigations and reports of J. Feytaud.[382] It was first noted there in 1910 and became very

[377] Harrington, W. H., *Can. Entom.*, vol. 23, pp. 22, 114 (1891).

[378] LeConte, J. L., and Horn, G. H., *Rhyncophora of America*, Proc. Am. Philos. Soc., vol. 15, p. 61 (1876).

Blatchley, W. S., and Leng, C. W., *Rhyncophora or weevils of North Eastern America*, p. 112 (1916).

Colcord, M., *Index of American Econ. Entom.*, vol. 3, p. 60 (1925).

Chittenden, F. H., *op. cit.*

Essig, E. O., *Insects of Western North America*, p. 496 (1926).

[379] Barrett, R. E., *A study of the immature forms of some species of Curculionidæ*, Univ. Calif. Pub. Entom., vol. 5, pp. 96–98, figs. 4, 10, 16, 22, 27 (1930).

[380] Also known as the cyclamen borer and black fruit weevil.

[381] Fabricius, J. C., *Syst. Entom.*, p. 155 (1775).

Herbst, J. F. W., *Käfer*, vol. 6, p. 347, t. 87, f. 5 (1795).

Stierlin, G., *Berlin Entom. Zeitsch.*, t. 2, p. 303 (1858).

Lucas, M. H., *Ann. Soc. Entom. France*, p. 50 (1869).

[382] Otiorhynchus sulcatus *in the Ile d'Oleron*, Bul. Soc. d'Etude et de Vulg. Zool. Agric., Bordeaux, vol. 13, pp. 7–14, 2 figs., 1 map (Jan., 1914); pp. 21–25, 53–55 (Feb. and Apr., 1914); vol. 15, pp. 102–105 (1916).

Ann. Service des Epiphyties, Paris, vol. 5, pp. 145–192, 17 figs. (1916–1917) (1918).

abundant in 1913, 1914 and succeeding years. The larvæ fed on the smaller roots and the adults attacked the leaves, often resulting in the death of the vines. In 1914, 1,400,000 adult weevils were captured and destroyed. The adults also infested peach, raspberry, strawberry, spiræa and English ivy in France. Grapevines are also reported injured by this weevil in Italy, along the Rhine in Germany,[383] and in southern England. It is also reported injurious to crops in the following European countries:

Russia—strawberries.
Holland—strawberries, rhododendrons, yew, laurel, bulbs, astilbe, herbaceous and ornamental plants.
Sweden—strawberries and raspberries in the open and ferns, rhododendrons and orchids in greenhouses.[384]
Scotland—cyclamen and begonia in greenhouses.
Ireland—ferns in greenhouses.
England—hops, rhododendrons, strawberries, ferns and saxifrage,[385] beets,[386] apple,[387] raspberry.[388]
Germany—gooseberries, strawberries, yew, cyclamen, rhododendron, camellia, greenhouse plants and forest trees.[389]
South Australia [390]—apple, beans, peas and other plants.
Tasmania [391]—especially serious pest of hops.

This weevil was early introduced into North America, probably upon potted plant materials from Europe. Specimens collected in

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On the parthenogenetic reproduction of Otiorhynchus sulcatus *F.*, C. R. Hebdom. Acad. Sci., Paris, vol. 165, no. 22, pp. 767–769 (Nov. 26, 1917). (No males found in dissecting 3,000 individuals.)

Le traitement arsenical contre les Otiorhynques, Rev. Zoöl. Agr. and App., vol. 24, pp. 76–82, 2 figs. (1925.)

Rev. Vit., vol. 48, no. 1227, pp. 5–10, pl. 1, colored plate (1918).

383 In 1920, 4,000 out of 6,000 young grafted grapevines were killed by this weevil in Berncastel-Cues, Germany. The larvæ barked the roots and the adults ate the opening buds in the spring. Thiem, H., *Zeitschr., angew. Entom.*, vol. 8, pp. 389–402 (1922).

Müller, C. A., *Der gefurchte Dickmaulrüssler*, Otiorhynchus sulcatus, Zeitschr. Pflanzenkrankh., vol. 11, pp. 214–216 (1902).

384 Kemner, V. A., Otiorhynchus sulcatus *Fab.*, *as an enemy of pot plants*, Trädgården, Stockholm, no. 18, p. 145, 2 figs. (May 10, 1916).

385 Fox-Wilson, G., Otiorhynchus rugifrons *and* O. sulcatus *as pests of Alpine plants*, Entom. Mthly. Mag., vol. 59, pp. 38–39 (1923).

386 Ormerod, E., *Manual of injurious insects and methods of prevention*, p. 361 (1890).

387 Theobald, F. V., *The insect and other allied pests of orchard, bush and hothouse fruits*, p. 121 (1909).

388 *Ibid.*, pp. 425–427, fig. 280.

389 Thiem, H., *A contribution to the biology and control of* O. sulcatus, Zeitschr. angew. Entom., vol. 8, no. 2, pp. 389–402 (May, 1922).

390 Lea, A. M., *South American plant weevils*, Jour. Dept. Agr. So. Austr., vol. 30, pp. 588–589, fig. 11 (1927).

391 Lea, A. M., *South American plant weevils*, Jour. Dept. Agr. So. Austr., vol. 30, pp. 588–589, fig. 11 (1927).

May and June, 1831, were turned over to Thomas Say who gave the species the manuscript name, *Otiorhynchus apiculatus*, which fact

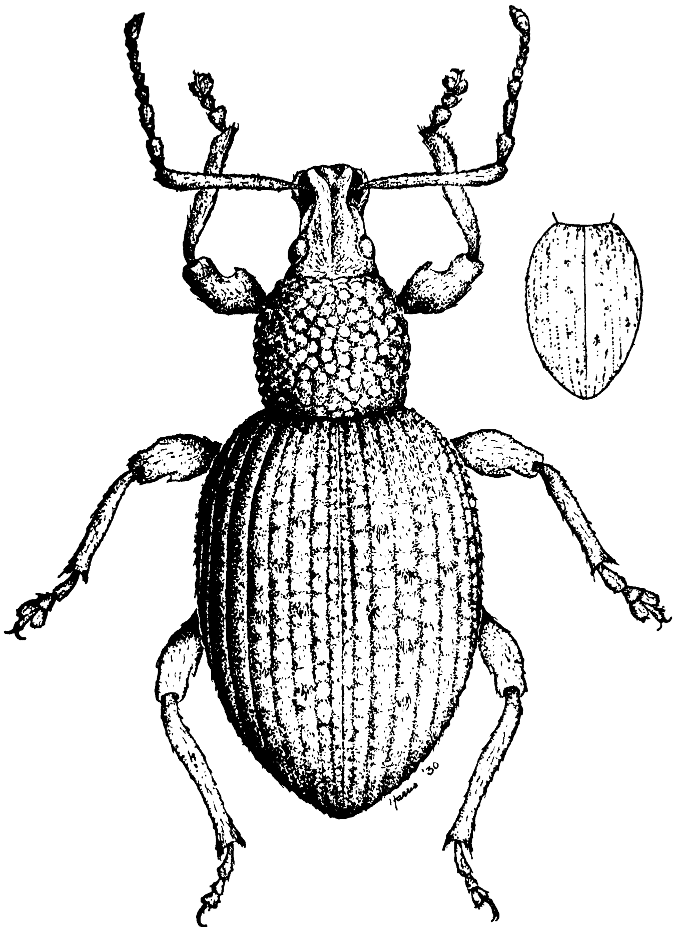

FIG. 74.—The black vine weevil, *Brachyrhinus sulcatus* (Fabr.), is one of the largest of the brachyrhinid weevils in Europe and North America. It is readily distinguished by the black color and the small patches of golden scales on the elytra (see small figure) and is also the most widely distributed and general feeder in the country. Adult × 7½.

was later reported by Harris in 1835.[392] In 1891, Harrington [393] called attention to the fact that specimens had been taken at Syd-

[392] Harris, T. W., *List of Insects of Massachusetts*, Rep. Geol. Mineral, Botany and Zoölogy of Mass. by Hitchcock, II, Amherst, pp. 32–82 (1835).
[393] Harrington, W. H., *Can. Entom.*, vol. 23, p. 22 (1891).

ney, Nova Scotia, in 1884, and again in 1890. Lintner [394] called attention to S. Henshaw's report that the weevil was injurious to bulbs and house plants in Massachusetts in 1885. Hagen [395] gave a short review of the history of the insect in North America up to 1890. He included references to the fact that Schœnherr [396] had placed Say's *O. apiculatus* Mss., as a synonym of *O. sulcatus* Fabr., to Riley's [397] report regarding injuries to strawberries in Europe, and to the injury of the weevil to flowers and bulbs of cyclamens in greenhouses at Montvale, Mass., in the year 1890. He further stated that there were six specimens of the weevil in the Cambridge Museum which had been collected by Jacob Boll in 1872.

In the same year, 1890, Schwarz [398] also reviewed the historical facts concerning this insect in North America and concluded: "As to the probable future course of this pest we do not anticipate that its injury will be a very serious one nor that it will spread very much, the species was already known from North America to coleopterists more than sixty years ago and is confined to the extreme northeastern portion of the country (from New York northward to Newfoundland and Nova Scotia). For this reason we are inclined to believe that it is not an imported species but that it belongs (with the other species of *Otiorhynchus* known from North America) to the circumpolar fauna. It is a peculiarity of the circumpolar insects that, with few exceptions, they do not seem capable of extending their range southward, at least not at a rapid rate, and they seem further incapable of doing very serious injury. The only notable exceptions that occur to us are *Agrotis fennica* Tausch. and *Otiorhynchus ovatus*. But either species has not spread over a large stretch of the country. These circumpolar species thus form a most striking contrast to the introduced and cosmopolitan insects and to some extent also to those insect pests which, originally belonging to the Central or South American faunas, have advanced from the south, e.g., the Cotton Worm, the Chinch Bug, the Harlequin Cabbage Bug, etc."

In 1913, Britton [399] gave a further account of the black vine

[394] Lintner, J. A., *Second Rept.*, State Entom. N. Y., p. 51 (1885).
[395] Hagen, H. A., *Psyche*, vol. 5, pp. 333–334 (1890).
[396] Schœnherr, C. J., *Genera et species Curculionidum*, vol. 7, p. 371 (1843).
[397] Riley, C. V., *Third Ann. Rept. Noxious, beneficial and other insects of the State of Missouri*, p. 11 (1871).
[398] Schwarz, E. A., *Insect life*, vol. 3, pp. 37–38 (1890).
[399] Britton, W. E., *Rept. Conn. Agr. Expt. Sta.*, 1913 (13th Rept. State Entom. Conn.), pp. 230–231, fig. b pl. 7 (1914).

weevil in the Eastern states. Additional information was as follows: injuring strawberries at Rochester, New York, in 1897;[400] cyclamens in Maine [401] and Victoria,[402] B. C.; under hemlock bark in New Jersey;[403] and injurious to the roots of Japanese yew, *Retinospora ericoides*, in a nursery at Pomfret, New Jersey, on April 2, 1913. It was also reported from New Canaan, Litchfield, Middleton, and New Haven, Conn. In 1916 Blatchley and Leng [404] gave the general distribution as follows: "Known from Newfoundland, New England and Toronto, Canada, to Vancouver."

In 1927 Smith [405] gave an extended account of the life history and habits of the weevil in Pennsylvania and New Jersey. It has also been noted in Maryland, Rhode Island, and Long Island, N. Y.

In the west it was first noted at Victoria, B. C., by Fletcher [406] in 1891, and by Treherne [407] in 1914. In the latter case it was injuring strawberry plants in the Lower Fraser Valley. He noted it injurious to cyclamens and primulas in British Columbia in 1916.[408]

It was present in Oregon prior to 1911 and reported by Wilson [409] in 1912 as injurious to strawberry plants but "not considered of especial importance by the growers." By 1927 it was known to occur in the Lower Willamette Valley in Clackamas, Multnomah, Yamhill, Washington, and Columbia counties as recorded by Mote and Wilcox,[410] who gave a very splendid account of the three important species of *Brachyrhinus* in Oregon. A. L. Melander found it a serious pest of cranberries in southwestern Washington, August

[400] Lintner, J. A., *13th Rept. State Entom.*, N. Y., p. 374 (1897).

[401] Johannsen, O. A., Maine Agr. Expt. Sta., *Bul. 187*, p. 8 (1911).

[402] Fletcher, J., *Insect life*, vol. 6, p. 284 (1891).

[403] Smith, J. B., *Insects of New Jersey*, Ann. Rept. N. J. State Museum, 1909, p. 379 (1910).

Weiss, H. B., *Jour. Econ. Entom.*, vol. 8, p. 552 (1915).

[404] Blatchley, W. S., and Leng, C. W., *Rhynchophora or weevils of North Eastern America*, p. 111 (1916).

[405] Smith, F. F., *The black vine weevil*, Brachyrhinus sulcatus *Fabr., as a pest in greenhouses and nurseries*, Jour. Econ. Entom., vol. 20, pp. 127–131 (1927).

[406] *Op. cit.*

[407] Treherne, R. C., Dom. Canada Dept. Agr., Div. Entom., *Entom. Bul. 8*, pp. 41–42 (1914); *Proc. Entom. Soc., B. C.*, no. 4, pp. 19–33 (1914).

[408] *Agr. Jour.*, Victoria, B. C., vol. 1, no. 10, p. 168 (1916).

[409] Wilson, H. F., *Bien. Crop Pest and Hort. Rept.*, Ore. Agr. Expt. Sta., 1911–1912, pp. 128, 131 (1912).

[410] Mote, Don C., and Wilcox, J., *The strawberry root weevils and their control in Oregon*, Ore. Agr. College Exp. Sta., Circ. 79, 24 pp., 7 figs., 1 pl. (1927).

26, 1922,[411] and Crowley [412] also reported it injurious to cranberries in Pacific County, Washington, in 1922–1923.

Hawley [413] first reported this weevil present in three counties in Utah on June 15, 1923.

It is not known when this weevil was first found in California and I do not know of any published reports prior to 1926.[414]

On May 17, 1915, I collected an adult specimen at Berkeley. In 1922 larvæ collected from the roots of Virginia creeper at San José, were reared and proved to be this insect. In early April, 1923, other larvæ, also taken in a lath house at San José, where they were seriously injuring the roots of spiræa and wistaria, transformed to adults, April 16, 1923. On May 19, 1923, I received adults from Eureka, where they were eating the fronds of maidenhair ferns. In June, 1926, I received a single adult specimen taken at Glendale in Los Angeles County. On May 1, 1927, A. Toyne found larvæ in boxes of cypress and oleander and adults eating cyclamen, hydrangeas, and young Canary Island palms in a nursery in Los Angeles. A short time afterwards in the same year the weevil was found in strawberry patches in Del Norte and Humboldt counties. On May 5, 1927, Leslie M. Smith found a large and serious infestation of this weevil in a raspberry patch at Sunnyvale. The larvæ were attacking the crowns and roots of the plants, many of which were killed.

In 1930 Barrett [415] described and figured the important characters of the larval and pupal forms of this and related injurious weevils and his paper now makes it possible to distinguish the immature stages.

The clover leaf weevil, *Hypera punctata* (Fabr.),[416] (Fig. 75) is a European insect, noted in France by Geoffroy [417] as early as 1762,

[411] U. S. Dept. Agr., Bur. Entom., *Insect Pest Surv. Bul.*, vol. 2, p. 209 (1922).

[412] Crowley, D. J., Wash. Agr. Expt. Sta., *33d Ann. Rept.*, 1922–1923, Bul. 180, pp. 73–75 (1923).

[413] Hawley, I. M., U. S. Dept. Agr., Bur. Entom., *Insect Pest Surv. Bul.*, vol. 3, p. 189 (1923).

[414] Essig, E. O., *Insects Western No. Am.*, pp. 493–494, fig. 405 (1926).

Lockwood, S., and Keifer, H. H., Calif. State Dept. Agr., *Mthly. Bul.*, vol. 19, pp. 21, 29, figs. 3, 8, 9a, 9b, 20a, 20b (1929).

[415] Barrett, R. E., *A study of the immature forms of some Curculionidæ*, Univ. Calif. Pub. Entom., vol. 5, pp. 92–94, figs. 2, 8, 14, 20, 25 (1930).

[416] Titus, E. G., *The genera* Hypera *and* Phytonomus *in America, north of Mexico*, Ann. Entom. Soc. Am., vol. 4, pp. 396–411, pls. xxv–xxvi (1911). Complete bibliography.

[417] Geoffroy, E. L., *Histoire abrégée des insectes qui se trouvent aux environs de Paris, etc.*, vol. 1, p. 275, *Curculio* no. 5.

and was described from Sweden by Fabricius [418] in 1775 as *Curculio punctatus*. It is widely distributed throughout Europe, eastern, northern and parts of central Asia, northern Africa, and much of

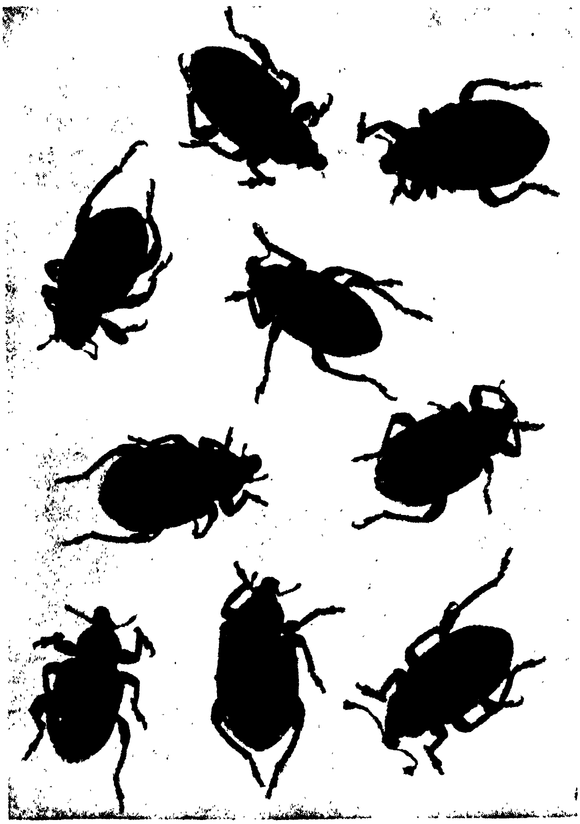

FIG. 75.—The clover leaf weevil, *Hypera punctata* (Fabr.), was first observed in North America, in Canada in 1853. It was first captured in California in 1908. (Specimens collected at Berkeley, California, June 10, 1921.)

North America. Its importance may be indicated by the fact that Titus lists 307 separate citations to articles on it up to 1911.

In North America this insect was taken in Canada as early as 1853, a specimen bearing that date was received by J. L. LeConte from a Mr. D'Urban. Another specimen, collected sometime before 1856, was also presented to LeConte by F. E. Melsheimer from Pennsylvania. The species described from these by LeConte as

[418] Fabricius, J. C., *Systema Entomologiæ, etc.*, p. 150, no. 119 (1775).

Phytonomus opimus [419] proved to be a synonym of *Hypera punctata* (Fabr.).[420]

In 1881 it was first noted as a destructive insect in this country. It was then injurious to clover at Barrington, New York, and was reported by Riley.[421]

The record of its discovery in various parts of this country are given by Titus as follows:

Canada, 1853 (D'Urban), J. L. LeConte.
Pennsylvania, before 1856, F. E. Melsheimer.
New York, 1881, C. V. Riley.
Vermont, 1882, J. A. Lintner.
Ohio, 1889.
New Jersey, 1890, C. Liebeck.
Pennsylvania, 1890, W. Stewart and S. S. Rathvon.
Connecticut, 1891.
Michigan, 1892, E. A. Schwarz.
Maryland, 1894.
West Virginia, 1894, A. D. Hopkins.
Indiana, 1894.
Illinois, 1897–1898, C. T. Brues.
Virginia, 1893, J. A. Lintner.
North Carolina, 1901, F. Sherman, Jr.
Texas, 1901–1902.
Rhode Island, 1902, Armstrong.
British Columbia, 1902, Hanham.
Massachusetts, 1906, C. A. Frost.
Tennessee, 1906, E. G. Titus.
Delaware, 1907.
Washington, 1907, E. C. Van Dyke.
California, 1908, E. C. Van Dyke, F. E. Blaisdell.
New Hampshire, 1909, C. A. Frost.
Kansas, 1910, E. G. Titus.
Iowa, 1910, R. L. Webster.
Wisconsin, 1910, O. Lugger.
Maine, H. C. Fall.
Washington, D. C.

It is also known to occur in Missouri, Oregon, Idaho, Mississippi, Utah, Arkansas, Nebraska, Alabama, and South Carolina.

This insect is troublesome to clover and alfalfa throughout its range in North America and many publications [422] have appeared

[419] LeConte, J. L., and Horn, G. H., *Rhyncophora of North America*, Proc. Am. Philos. Soc., vol. 15, pp. 124, 415 (1876).

[420] LeConte, J. L., Trans. Am. Entom. Soc., vol. 9, *Proc.*, p. xxxvi (1881–1882).
Riley, C. V., *Am. Naturalist*, vol. 16, pp. 248–249 (1882).

[421] Riley, C. V., *Am. Naturalist*, vol. 15, pp. 750–751, 912–914 (1881).

[422] Lintner, J. A., *41st Rept. N. Y. State Agr. Soc.*, pp. 40–50 (1882).
First Rept., State Entom., N. Y., pp. 247–253, fig. (1883).
Riley, C. V., *The clover leaf-beetle*, U. S. Commr. Agr., Rept., 1881–1882, pp. 171–179, pl. 10, fig. 1 (1882).
Webster, F. M., Ohio Agr. Exp. Sta., *Bul. 68*, pp. 27–31, fig. (1896).
Johnson, W. G., U. S. Dept. Agr., Div. Entom., *Bul. 9*, n. s., pp. 80–82 (1897); *Bul. 26*, n. s., p. 96 (1900).
Folsom, J. W., Ill. Agr. Exp. Sta., *Bul. 134*, pp. 155–164, figs. 13–16 (1909).
Haseman, L., Mo. Agr. Exp. Sta., *Bul. 134*, pp. 25–26, fig. 24 (1915).
Knab, F., *Proc. Entom. Soc. Wash.*, vol. 17, pp. 155–156 (1915).
Parks, T. H., *The clover-leaf weevil*, Jour. Econ. Entom., vol. 7, p. 297 (1914).
Tower, D. G., and Fenton, F. A., *Clover-leaf weevil*, U. S. Dept. Agr., Bul. 922, prof. paper, 18 pp., 9 figs. (1920).

concerning it. In 1926 Larrimer [423] makes this statement regarding its economic importance. " The clover-leaf weevil is one of the important clover pests. It causes considerable worry to the farmer and is sometimes responsible for more or less severe injury to his clover crop before its depredations are checked by the fungus disease which usually controls it in the larval or grub stage."

As already noted, this insect was first taken in California [424] in the San Francisco Bay region by E. C. Van Dyke and F. E. Blaisdell in 1908. On September 10, 1920, Van Dyke collected adults in Berkeley. In June, 1921, I noted a white clover lawn considerably injured by the weevil in Berkeley. I also received adults reported as injuring alfalfa in June, 1921, from Humboldt County. On September 10, 1921, I received a large number of weevils from Palo Cedro, Shasta County, California, with specimens of alfalfa showing injury by the insect. Although probably generally distributed in the northern part of the state, so far no extensive serious damage to either clover or alfalfa has been noted in the state.

In 1930, Barrett [425] described and figured the important characters of the larval and pupal stages and has thus made it possible to readily distinguish the immature forms.

The alfalfa weevil, *Hypera postica* (Gyllenhal) [*Phytonomus posticus* (Gyllenhal)],[426] (Fig. 76) is a European insect which is

Herrick, G. W., and Hadley, C. H., Jr., *The clover-leaf weevil*, Cornell Agr. Exp. Sta., Bul. 411, 12 pp., 4 figs., 2 pls. (1922).

Larrimer, W. H., *The clover-leaf weevil and its control*, U. S. Dept. Agr., Farmers' Bul. 1484, 5 pp., 7 figs. (1926).

[423] Larrimer, W. H., *ibid.*, inside cover (1926).

[424] Essig, E. O., *Insects of Western No. Am.* (New York, Macmillan, 1926), pp. 495–496, fig. 406.

[425] Barrett, R. E., *A study of the immature forms of some species of Curculionidæ*, Univ. Pub. Entom., vol. 5, pp. 98–100, figs. 6, 11, 17, 23 (1930).

[426] Titus, E. G., *Desert farmer*, Salt Lake City, Utah, p. 7 (July 27, 1907); p. 26 (Sept. 3, 1908).

The alfalfa leaf-weevil, Jour. Econ. Entom., vol. 2, pp. 148–153 (1909) (*Phytonomus murinus* Fabr.); vol. 3, pp. 459–470 (1910).

The alfalfa leaf-weevil, Utah Agr. Exp. Sta., Ext. Dept. Bul. 1, 4 pp. (1909); *Bul. 110*, 72 pp., 14 pls. (1910).

On the life history of the alfalfa leaf-weevil, Jour. Econ. Entom., vol. 3, pp. 459–470 (1910).

The genera Hypera *and* Phytonomus *in American, north of Mexico*, Ann. Entom. Soc. Am., vol. 4, pp. 452–468, pls. xxxi–xxxiv (1911) (complete Bibliography).

The control of the alfalfa weevil, Utah Agr. Exp. Sta., Circ. 10, pp. 107–120, 3 figs., 2 pls. (1913).

Webster, F. M., *The alfalfa weevil* (Phytonomus murinus), U. S. Dept. Agr., Bur Entom. Circ. 137, 9 pp., 10 figs. (1911).

Preliminary report on the alfalfa weevil, *ibid.*, Bul. 112, 47 pp., 27 figs., 13 pls. (1912).

generally distributed throughout Europe, northern Africa, and western Asia. Although often abundant in the Old World it is not

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Parks, T. H., *The alfalfa weevil*, Idaho Agr. Exp. Sta., Ext. Bul. 7, 22 pp., 12 figs. (1913).

Effect of temperature upon the oviposition of the alfalfa weevil (Phytonomus posticus *Gyll.*), Jour. Econ. Entom., vol. 7, pp. 417–421 (1914).

Ellis, W. O., *The alfalfa weevil* (Phytonomus posticus *Gyll.*), Wash. Agr. Exp. Sta., Pop. Bul. 70, 4 pp., 4 figs. (1914).

Cooley, R. A., *The alfalfa weevil*, Mont. Agr. Exp. Sta., Circ. 35, pp. 191–206, 7 figs., 2 pls. (1914).

Kalmbach, E. R., *Birds in relation to the alfalfa weevil*, U. S. Dept. Agr., prof. paper 107, 64 pp., 3 figs., 5 pls. (1914).

Rockwood, L. P., Sporotrichum globuliferum *Speg., a natural enemy of the alfalfa weevil*, Jour. Econ. Entom., vol. 9, pp. 493–499 (1916).

Reeves, G. I., *The alfalfa weevil investigations*, Jour. Econ. Entom., vol. 10, pp. 123–130 (1917).

The control of the alfalfa weevil, U. S. Dept. Agr., Farmers' Bul. 1528, 22 pp., 15 figs. (1927).

Some early history of alfalfa weevil quarantine, Calif. State Dept. Agr., spec. pub. 54, pp. 65–73 (1925).

Reeves, G. I., Miles, P. B., Chamberlin, T. R., Snow, S. J., and Bower, L. J., *The alfalfa weevil and methods of controlling it*, U. S. Dept. Agr., Farmers' Bul. 741, 16 pp., 7 figs. (1916).

Reeves, G. I., Chamberlin, T. R., and Pack, K. M., *The turning point in weevil injury determines the time to spray*, *ibid.*, Farmers' Bul. 1185, 20 pp., 9 figs. (1920).

Hagan, H. R., *The alfalfa weevil*, Utah Agr. Exp. Sta., Circ. 31, 8 pp., 4 figs. (1918); Calif. State Dept. Agr., *Mthly. Bul.*, vol. 8, pp. 469–477 (1919).

Henderson, W. W., *Interstate quarantine on alfalfa weevil*, Proc. 1st Plant Quar. Conf., Calif. State Hort. Com., Mthly. Bul., vol. 8, pp. 461–469 (1919).

List, G. M., and Wakeland, C. C., *Alfalfa weevil* (Phytonomus posticus *Gyll.*), 10th Rept. Colo. State Entom., Circ. 27, pp. 13–37, 13 figs. (Aug. 19, 1919).

Fulton, B. B., *Third crop Pest and Hort. Rept.*, Oregon Agr. Exp. Sta., 1915–1920, pp. 116–117, figs. 30A, 31 (1921).

Webb, H. J., *Investigation of means of distributing alfalfa weevil*, 5th Conv. Western Plant Quar. Bd., Calif. State Dept. Agr., Mthly. Bul., vol. 12, pp. 258–262 (1923).

Wakeland, C. C., *Alfalfa weevil*, Phytonomus posticus *Gyll.*, Progress Rept. 1919. 11th Rept. Colo. State Entom., *Circ. 28*, pp. 22–34, 6 pls., 1 col. pl. (Aug., 1920).

Alfalfa weevil and its control in Idaho, Idaho Agr. Expt. Sta., Ext. Circ. 23, 4 pp. (1920); *Ext. Bul. 50*, 27 pp., 9 figs. (1921); *Circ. 34*, 11 pp. (1924).

New developments in alfalfa weevil activity and control, Jour. Econ. Entom., vol. 17, pp. 330–337, fig. 8 (1924).

Seasonal variation as it affects the activity and control of the alfalfa weevil in Idaho, Idaho Agr. Exp. Sta., Bul. 138, 11 pp. (1925).

Cook, W. C., *The distribution of the alfalfa weevil* (Phytonomus posticus *Gyll.*), *A study in physical ecology*, Jour. Agr. Research, vol. 30, pp. 479–491, 12 figs. (1925).

Chamberlin, T. R., *Studies of the parasites of the alfalfa weevil in Europe*, Jour. Econ. Entom., vol. 17, pp. 623–632 (1924).

Introduction of parasites of the alfalfa weevil into the U. S., U. S. Dept. Agr., Dept. Circ., 301, 9 pp., 5 figs. (1924).

A new parasite of the alfalfa weevil, Jour. Econ. Entom., vol. 18, pp. 597–602 (1925).

The introduction and establishment of the alfalfa weevil parasite, Bathyplectes curculionis (*Thoms.*), *in the U. S.*, *ibid.*, vol. 19, pp. 302–310 (1926).

Snow, S. J., *The alfalfa weevil in Nevada and its control by spraying*, Nevada Agr. Exp. Sta., Bul. 108, 22 pp., 4 figs. (1925).

Effect of ovulation upon seasonal history in the alfalfa weevil, Jour. Econ. Entom. vol. 21, pp. 752–761, figs. 50–54 (1928).

Newton, J. H., *Status of the alfalfa weevil in Colorado*, Jour. Econ. Entom., vol. 19, pp. 371–374 (1926).

specially important as an economic insect, except in a few places,[427] yet Titus [428] gives 314 separate citations to European literature and lists no less than twelve specific synonyms.

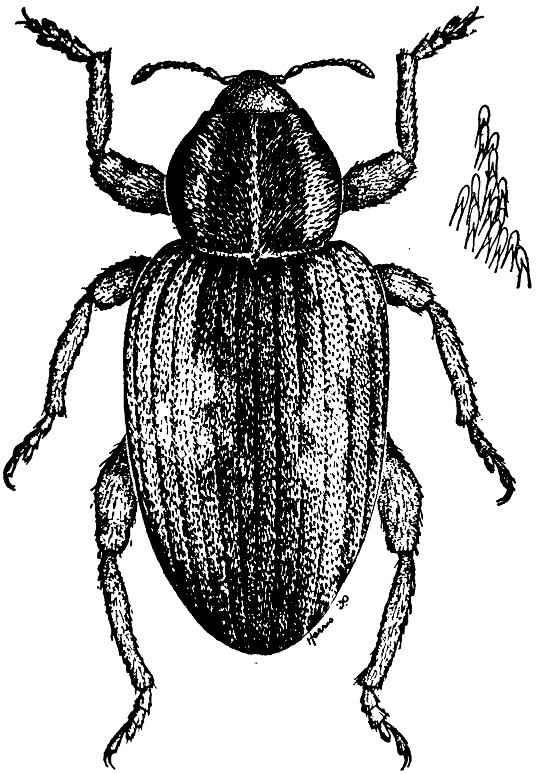

FIG. 76.—The alfalfa weevil, *Hypera postica* (Gyll.), made the remarkable jump from southern Europe to the middle of the Great Basin in the United States. It was first observed in Utah in the spring of 1904 and has since spread to a number of the western states. Adult × 15, scales × 60.

It was originally described as *Curculio variabilis* by Herbst [429] in

Essig, E. O., *Insects Western No. America* (New York, Macmillan, 1926), pp. 496–497, fig. 407.

Schweis, G. G., *Alfalfa weevil control*, 9th Conf. Western Plant Quar. Bd., Calif. State Dept. Agr., Spec. Pub. 85, pp. 80–82 (1928).

[427] The alfalfa weevil is considered to be a major pest in southern France (1914), Italy (1889–1911), Turkestan (1913) and a minor pest in Sweden (1912), Denmark (1916), Germany (1922), Southern Russia, Transcaucasia (1916–1917), Cook, W. C., *op. cit.*, p. 482 (1925).

[428] Titus, E. G., *Ann. Entom. Soc. Am.*, vol. 4, pp. 452–456 (1911).

[429] Herbst, J. F. W., *Natursystem aller bekannten in-und aüslandischen Insecten, etc.*, Käfer, vol. 6, p. 263, no. 80, fig. 1 (1795).

1795 and later as *Rhynchænus posticus* by Gyllenhal,[430] in 1813. In present European literature,[431] *Hypera variabilis* (Herbst) is the accepted name, whereas in America we are still holding to *Hypera postica* (Gyll.).[432]

In North America the weevil was first introduced into Utah. An account of this first infestation is given by Titus[433] as follows: "The earliest record obtainable of its presence in Utah is its occurrence in the spring of 1904 when it was present on a farm on the east side of Salt Lake City. During the years 1905 and 1906 it spread for several miles. I first saw the beetle and larvæ at work early in July, 1907, when I went to Utah as Entomologist; it had not then been reported from America. During the next two years it spread rapidly, reaching a number of outlying districts and probably passed over the first range of the Wasatch Mountains into the Weber Valley." By July 1, 1910, it had spread to 8 counties or an area of about 60 x 70 miles in Utah and became a pest of major importance to alfalfa.

Investigations of the life history and habits of the insect were begun by E. G. Titus, entomologist in the Utah Agricultural Experiment Station in 1907. In 1911 the Bureau of Entomology, U. S. D. A. also began work in Utah, and has continued the same to the present time.

The continued distribution of the weevil was fairly rapid—the natural annual advance was about ten miles. Early in 1913 it had spread to 14 counties in Utah, one county in southwestern Wyoming and three counties in southeastern Idaho. By December of

[430] Gyllenhal, L., *Insecta Suecica descripta*, vol. 1, pt. 3, p. 113, no. 41 (1813).

[431] *The Review of Applied Entomology*, Series A: Agriculture. London.

[432] L. L. Buchanan has submitted the following statement with regard to the proper name to be used for the alfalfa weevil:

"In regard to Prof. Essig's question as to the proper scientific name for the alfalfa weevil, I would favor the continued use of *postica* Gyllenhal in American literature rather than changing to the *variabilis* Herbst of European authors. This recommendation is based on references and statements in Titus' monograph showing that *variabilis* Herbst 1795 is preoccupied by *variabilis* Fabricius 1777 and 1781. The case seems clear enough, so far as the above evidence goes, except for one point, namely, the omission of *variabilis* Fabr. from the European catalog. However, I understand that European writers sometimes do eliminate from their lists certain old names that appear undesirable to them, and quite likely something of the sort has happened in the case of *variabilis* Fabr.

"Pressure of other work makes it entirely impossible for me to go into this matter thoroughly, as that would mean the examination of a large number of earlier references. However, I doubt if even a critical study of the question would alter the conclusion that *postica* Gyll. is the name to use."

[433] Titus, E. G., *Ann. Entom. Soc. Am.*, vol. 4, pp. 462–463 (1911).

the same year it occurred throughout much of the alfalfa region of the southern half of Idaho. It was found in Delta and Gunnison counties, Colorado,[434] in 1917, at Tippetts and near Reno, Nevada, in 1920,[435] in Sierra County, California, July, 1923,[436] and at Ontario, Oregon, May 1925.[437] In 1925 it was first found on the eastern slope of the Rocky Mountains in Wyoming.[438] In California it occurred in Sierra, Lassen, and Plumas counties. The next year it was taken in Goshen [439] and Carbon [440] counties, Wyoming, near the Nebraska state line. In 1928 a map [441] indicating the distribution of the alfalfa weevil showed it to occur in the different states approximately as follows:

California—In the extreme eastern portions in areas on the eastern slopes of the Sierra Nevada Mountains.
Colorado—In the northwestern corner.
Idaho—Throughout much of the southern half.
Nebraska—A small area at the extreme western border adjacent to Wyoming.
Nevada—An irregular narrow strip along the eastern border, thence across the northern part and terminating at the California line in the Lake Tahoe region.
Oregon—Several infestations in the eastern part.
Utah—The entire state excepting the southeastern corner.
Wyoming—The extreme southern area from Idaho to Nebraska.

In California the alfalfa weevil,[442] as above stated, spread naturally into California from Nevada. It was first noted in Sierra County about two miles west of the town of Verdi, Nevada, July 6, 1923. As soon as the insect was known to occur in Nevada the

[434] List, G. M., and Wakeland, C. C., *op. cit.*, p. 13 (1919).
[435] Snow, S. J., *op. cit.*, p. 5 (1925).
[436] Calif. State Dept. Agr., *Mthly. Bul.*, vol. 12, pp. 359–360 (1923).
U. S. Dept. Agr., Bur. Entom., *Insect Pest Surv. Bul.*, vol. 3, pp. 176, 223–224 (1923). By natural spread from Nevada.
[437] Thompson, B. G., U. S. Dept. Agr., Bur. Entom., *Insect Pest Surv. Bul.*, vol. 5, p. 168 (1925).
[438] Corkings, C. L., *ibid.*, vol. 5, p. 238 (1925).
[439] *Ibid.*, vol. 6, pp. 197, 240 (1926).
[440] Reeves, G. I., *ibid.*, vol. 6, p. 240 (1926).
[441] *Ibid.*, vol. 8, p. 352 (1928).
[442] Cook, A. J., *The alfalfa weevil, an alarming menace*, Calif. Hort. Com., Mthly. Bul., vol. 1, pp. 19–22, figs. 3–8 (1911).
Smith, H. S., *The alfalfa weevil, ibid.*, vol. 6, pp. 295–297, 3 figs. (1917).
Weldon, G. P., *The alfalfa weevil and State Quarantine, ibid.*, vol. 7, pp. 484–487, 2 figs. (1918).
Stevens, V. G., *Report of a recent investigation for evidence of alfalfa weevil in alfalfa fields adjacent to the Salt Lake Railroad, ibid.*, vol. 7, pp. 546–548, 1 fig. (1918).

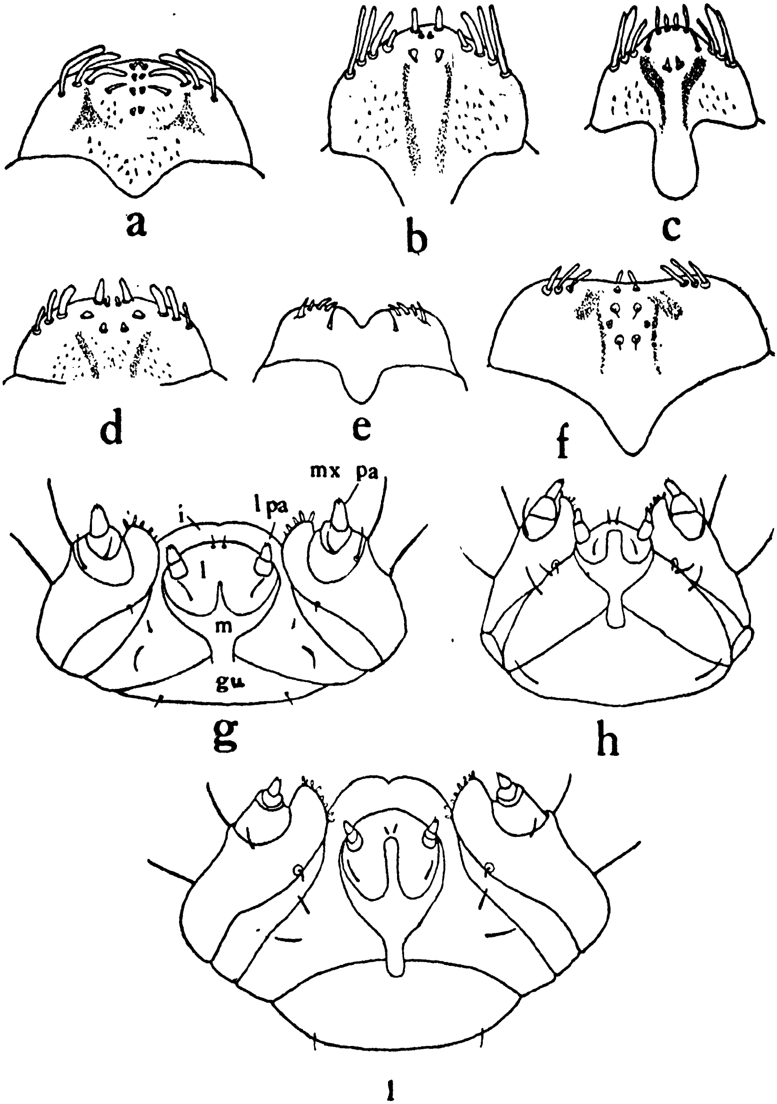

FIG. 77.—Larval characters of weevils. Epipharynx: **a**, *Pantomorus godmani* (Crotch); **b**, *Brachyrhinus sulcatus* (Fabr.); **c**, *B. ovatus* (Linn.); **d**, *B. rugosostriatus* (Gœze); **e**, *Hypera punctata* (Fabr.); **f**, *Listroderes obliquus* Gyll. Mouth parts, ventral view: **g**, *Pantomorus godmani* (Crotch) (gu, gula; i, ligula; l, labium; l pa, labial palpus; m, mentum; mx pa, maxillary palpus); **h**, *Brachyrhinus ovatus* (Linn.); **i**, *B. sulcatus* (Fabr.). (After R. E. Barrett, 1930.)

California State Department of Agriculture established border quarantine stations [443] on the highways along the border between Nevada and California. At these stations specimens of adults of

FIG. 78.—Photograph showing turnips injured by the larvæ of the vegetable weevil, *Listroderes obliquus* Gyll. The leaves may be eaten away and the roots completely perforated. The insect has been successfully controlled during the past few years. (Photograph taken February 24, 1927.)

the alfalfa weevil were regularly intercepted, particularly in camping equipment, in automobiles entering California from eastern points. As an illustration, during the month of June, 1924, live

[443] Jacobsen, W. C., Calif. State Dept. Agr., *Mthly. Bul.*, vol. 14, pp. 152, 156 (1926).

weevils were found in the camping equipment of 61 automobiles and as many as 140 adults in a single car.[444] As a further means of protecting California alfalfa fields, the California State Department of Agriculture has maintained quarantine regulations against the entire infested area since 1912. Quarantine Order no. 14 was issued

FIG. 79.—The larvæ of the vegetable weevil, *Listroderes obliquus* Gyll., at work on turnip (left) and carrot (right). (Photograph taken February 24, 1927.)

August 13, 1912, and new orders and amendments were issued as knowledge of the life history and habits and its distribution increased. On May 23, 1925, Quarantine Order no. 7 (New Series) was issued in which seven states infested with the weevil were included in the quarantine. Two amendments have since been made. So far the spread of the insect in California has been confined to the areas east of the summit of the Sierras. In 1925 it occurred in the counties of Sierra, Plumas, and Lassen, and while it has since been dispersed there, it has not yet reached the great centers of alfalfa culture in this state.[445]

[444] U. S. Dept. Agr., Bur. Entom., *Insect Pest Surv. Bul.*, vol. 4, p. 163 (1924).
[445] Calif. State Dept. Agr., *Mthly. Bul.*, vol. 15, p. 122 (1926).

In addition to the development of arsenical sprays and dusts for the control of the alfalfa weevil, the Bureau of Entomology began the introduction of parasites from Europe in 1911. This important phase of biological control was begun by W. F. Fiske, who collected parasites in Europe in 1911, and was continued by H. S. Smith, 1912 and W. R. Thompson, 1912 and 1913. The most promising parasite, *Bathyplectes curculionis* (Thompson), an ichneumonid, was one of the first. Forty adults were liberated at Sandy, Utah, by T. H. Parks in 1911. The next year G. I. Reeves released 48 males and 121 females in the alfalfa fields infested with the weevil. In 1913 and 1914 P. H. Timberlake and L. P. Rockwood liberated 1,335 adult parasites directly in the field. It early became established throughout most of the infested territory and is often very abundant. It is an internal parasite of the larvæ of the alfalfa weevil and destroys as high as 95% in some of the older weevil-infested areas.

The vegetable weevil, *Listroderes obliquus* Gyllenhal[446] (Figs. 77–81), was first recorded in the United States at McHenry, Stone

[446] Gyllenhal, L., *Genera et species Curculionidum, etc.*, by C. J. Schoenherr, vol. 2. pt. 1, p. 277 (1834). Original description.

Lea, A. M., *Trans. and Proc. Royal Soc.*, So. Australia, vol. 33, pp. 174–175 (1909).

French, Jr., C., *Jour. Dept. Agr.*, Victoria, Australia, vol. 6, pp. 754–755 (Dec., 1908); vol. 7, pp. 642–643, 11 figs. (Oct., 1909). (*Desiantha nociva* Lea.)

Handb. Destructive Ins. Victoria, pt. 5, pp. 41–43 (1911).

Froggatt, W. W., *The buff-colored tomato weevil* (Desiantha nociva), Agr. Gaz. N. S. W., vol. 26, p. 1065 (1915).

Harned, R. W., Miss. State Plant Bd., *Quart. Bul.*, vol. 2, pp. 6–8 (1922).

Bur. Entom., U. S. Dept. Agr., *Insect Pest Surv. Bul.*, vol. 2, p. 130 (1922); vol. 4, p. 44 (1924); vol. 5, pp. 30–31, 67–68, 187, 256–257, 313 (1925); vol. 6, pp. 43–44, 70–71, 157, 337 (1926); vol. 7, pp. 24–25, 44, 56, 67, 397 (1927); vol. 8, pp. 8, 18–19, 27, 34, 69, 361 (1928).

Gurney, W. B., *Agr. Gaz. N. S. W.*, vol. 34, pp. 905–907 (1923).

Chittenden, F. H., *The Australian tomato weevil introduced in the South*, U. S. Dept. Agr., Circ. 282 (1923).

An introduced beetle related to the tomato weevil, Proc. Biol. Soc. Wash., vol. 39, pp. 71–74, pl. 1 (1926).

Bynum, E. K., *Notes on the Australian tomato weevil*, State Plant Bd. Miss., Quart. Bul., vol. 2, p. 12 (1923).

Controlling the Australian tomato weevil, *ibid.*, vol. 3, p. 22 (1924).

McCarthy, T., *Brown vegetable weevil*, Agr. Gaz. N. S. W., vol. 35, pp. 573–580, 7 figs. (1924).

Graf, J. E., U. S. Dept. Agr., *Ann. Rept.*, p. 22 (1925).

Van Dyke, E. C., *Pan-Pac. Entom.*, vol. 3, p. 63 (1926).

Lewis, H. C., *The vegetable weevil in California*, Calif. State Dept. Agr., Mthly. Bul., vol. 16, pp. 378–392, figs. 81–93, bibliography (1927).

Lockwood, S., and Keifer, H. H., Calif. State Dept. Agr., *Mthly. Bul.*, vol. 19, pp. 18, 22–25, 31, figs. 7, 24 (1930).

Lewis, H. C., and Gammon, C., *The vegetable weevil for the season 1927–28*, *ibid.*, vol. 17, pp. 482–492, figs. 79–85 (1928).

Calif. State Dept. Agr., *Mthly. Bul.*, vol. 16, pp. 375, 585–586, 653–654 (1927): vol. 17, p. 282 (1928).

County, Mississippi, on March 28, 1922, by F. H. McHenry, who observed it attacking potato, tomato, and turnip plants. It was later identified as *Desiantha nociva* Lea. By July, 1923, the insect was found present in five counties of southern Mississippi. In February, 1927, W. E. Hinds reported it injurious to carrots, shallots, etc., at Destrehan and St. Rose, Louisiana, A. Boyles

FIG. 80.—The pupæ of the vegetable weevil, *Listroderes obliquus* Gyll., as they appear in the cells which are one or two inches below the surface of the soil. (Specimens collected in San José, April 7, 1927.)

and J. M. Robinson noted it attacking cabbage and turnips in Mobile County, Alabama, in March and April of the same year. By the end of 1927 it was known to occur in 8 parishes in Louisiana, 32 counties in Mississippi, 7 counties in Alabama, and 2 counties in Florida. In 1928 it extended to 40 counties in Mississippi and somewhat northward in the already infested counties of the other states.

In the spring of 1918, H. H. P. Severin was growing a number of vegetables in a small garden at 2328 Grove Street, Berkeley, California. Among other things he observed a beetle larvæ seriously attacking radishes. He did not know the insect and due to

This insect has been known as the Australian tomato weevil, buff-colored tomato weevil, South American tomato weevil, and turnip weevil. The above common name has been approved by the American Association of Economic Entomologists. It was first noted in Australia in 1908 and supposed to be a native species, but later proved to be indigenous to South America. It has also been designated as *Listronotus obliquus* Fabr.

the press of other problems did not succeed in rearing adults. However, he did have a photograph made, a copy of which he presented to me a year or two afterwards. During the Berkeley fire in 1923, Severin lost many photographs, including those made in 1918. In selecting certain pictures for this book in February, 1930, I came across the one of the larvæ infesting radishes; they appear to be the larvæ of the vegetable weevil and if so proves to be the first record of the insect in America.

Larvæ of the vegetable weevil were again discovered in California on carrots at San José in February, 1926, by L. R. Cody, Horticultural Commissioner of Santa Clara County. Adults obtained in April were definitely determined as such by H. S. Barber, U. S. National Museum. Adults, however, had been taken on the campus of the University of California at Berkeley in 1925 by E. C. Van Dyke and F. C. Hadden, but were not recognized as this insect until after the discovery at San José had been made known. It is not known when or how this insect reached California, but it must have been in ships' stores brought from South America, the Southern States, or from Australia, sometime before 1918. An inspection of the San Francisco Bay Region has shown the beetle to occur in the counties of San Francisco, San Mateo, Santa Clara, Santa Cruz, Alameda, Contra Costa, Solano, Napa, and Marin.

The weevil is particularly destructive to winter grown vegetables and because of this fact is of great economic concern. To date it is known to infest amaranth, anise, globe artichoke, aster, beet, borecole, broccoli, brussels sprouts, cabbage, Chinese cabbage, cardoon, carrot, cauliflower, celeriac, celery, chickory, cole, collards, dandelion, dill, dock, eggplant, endive, escrolla, fennel, finocchio, garlic, hoarhound, kale, kohlrabi, leek, lettuce, malva, milk thistle, mustard, nettle, onion, parsley, parsnip, pigweed, poison hemlock, potato (leaves), radish, rape, salsify, sorrel, spinach, sweet anise, Swiss chard, tomato (plants), and turnip.

Steps were immediately taken by the State Department of Agriculture to prevent the further spread of the weevil and suitable quarantine regulations put into force in the form of Pest Control Regulation No. 3, issued October 5, 1927, revised March 12, 1928.

Life history and control studies of the vegetable weevil were undertaken by H. C. Lewis, assistant entomologist, State Department of Agriculture, and continued until 1927, when the Division of Entomology, University of California, delegated these duties

first to F. H. Wymore and L. M. Smith and shortly afterwards to R. W. Burgess and O. H. Lovell in coöperation with the Bureau of Entomology, U. S. D. A. The studies of these various investigators showed that the insect could be effectively and economically con-

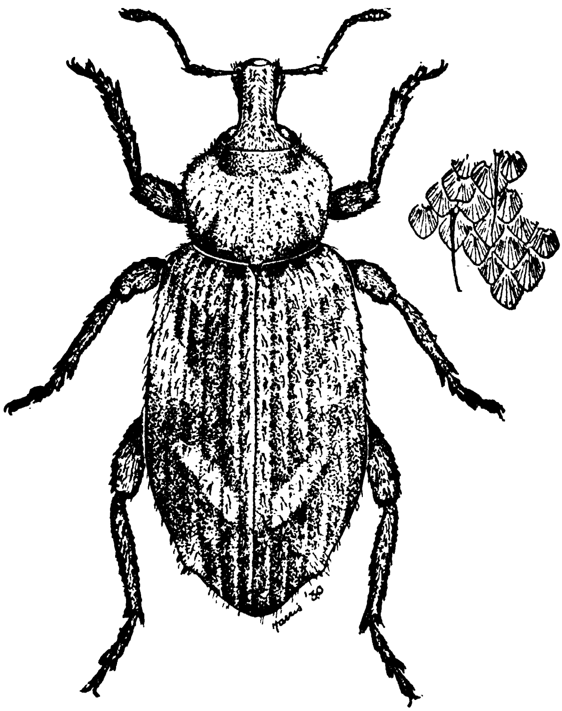

FIG. 81.—The adult vegetable weevil, *Listroderes obliquus* Gyll., is readily distinguished by the brown and drab colors, the two rather prominent posterior tubercles, and the peculiar fan-shaped or leaf-like scales on the dorsum. This insect now occurs in several southern States and in California. Adult × 7½, scales × 60.

trolled by sodium fluosilicate—at least this was so demonstrated by Lovell during the winter and spring of 1928–1929.

In 1930 Barrett [447] also described and figured the important characters of the larvæ and pupæ of this and other related weevils and has made it possible to readily distinguish the immature stages.

The pepper weevil or barrenillo, *Anthonomus eugenii* Cano, (Figs. 82, 83) was first described in 1894 [448] from Mexico where it

[447] Barrett, R. E., *A study of the immature forms of some species of Curculionidæ*, Univ. Calif. Pub. Entom., vol. 5, pp. 100–103, figs. 6, 12, 18, 24, 28 (1930).
[448] Cano y Alcacia, D., *La Naturaleza* (2) vol. 2, pp. 377–379, t. 17 (1894).

was attacking various "chilies" (*Capsicum*). It was again described as *A. æneotinctus* by Champion in 1903 [449] who reported it from Guanajuato, Tupataro, Sayula, Jalapa, Orizaba, and Amula, Mexico.

In the United States it was first noted as a pest of peppers by Louis Lamm at Boerne, Texas, in October, 1903. C. M. Walker of

FIG. 82.—The pepper weevil, *Anthonomus eugenii* Cano, a Mexican species, was first observed attacking peppers in the United States in Texas in 1903, in New Mexico in 1922, and in California in 1923. Since then it has become the most important pest of peppers in these states. The photograph shows the type of injury to peppers as viewed from the exterior.

the Bureau of Entomology had his attention called to it the following year and officially reported its attacks on peppers at the same locality on October 26, 1904.[450] It was determined by E. A. Schwarz as *A. æneotinctus* Champ. It was again referred to as a pest of peppers in Texas by W. D. Hunter and W. E. Hinds in the same year.[451] F. C. Pratt [452] worked out the life history of the insect in Texas, where it was found to be a serious pest of bell or sweet

[449] Champion, G. C., *Biol. Centr.-Americana, Coleoptera*, vol. 4, pt. 4, pp. 156, 169, 170, 723 (1902–1906).
Entom. News, vol. 18, p. 366 (1907).

[450] Walker, C. M., U. S. Dept. Agr., Bur. Entom., *Bul. 54*, pp. 43–48, fig. 16, pl. 1 (1905).

[451] U. S. Dept. Agr., Bur. Entom., *Bul. 51*, p. 67, pl. 10, fig. 45 (1905).

[452] U. S. Dept. Agr., Bur. Entom., *Bul. 63*, pt. v, pp. 55–58, fig. 10, pl. 2 (1907).

pepper, chili and tabasco peppers in many places in that state. He pointed out the fact that the insect had no doubt been introduced from Mexico.

In 1923 W. E. Emery reported that it did 50% damage to the crop of chili peppers at Mesilla Park, New Mexico, the previous year, 1922.[453] Since then it was reported [454] at San Benito, Mississippi, June 5, 1924, by M. M. High and was first discovered in California by R. E. Campbell injuring bell peppers near La Habra, Orange County, November 23, 1923. In view of the fact that Mexican immigrants usually brought chili peppers along with them into southern California, the insect was no doubt brought with them and may have been established in the small Mexican gardens years before it was finally discovered in commercial plantings. R. E. Campbell [455] and C. J. Elmore,[456] as members of the Bureau of Entomology, have been charged with the study of this insect in California and with the aid of A. C. Davis are still conducting investigations relative to it. By August 25, 1926, Elmore reported that from 50% to 60% of the pepper crop of 8,000 acres in southern California, chiefly in Orange County was destroyed by the pepper weevil. On September 30, 1926, I received specimens from Chino, San Bernardino County, and on March 25, 1927, R. R. McLean noted it damaging peppers at Vista and Bonsall, San Diego County. It was reported from Ventura County, January, 1928. In this year

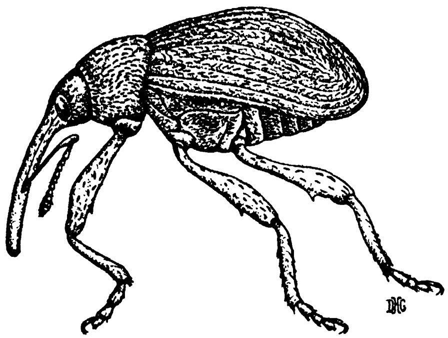

FIG. 83.—The adult pepper weevil, *Anthonomus eugenii* Cano, is a very small gray insect with a long snout. × 15.

[453] U. S. Dept. Agr., Bur. Entom., *Insect Pest Survey Bul.*, vol. 3, pp. 287, 324 (1923).

[454] *Ibid.*, vol. 4, pp. 136, 276 (1924); vol. 5, p. 264 (1925); vol. 6, pp. 106, 253–254, 318, 338 (1926); vol. 7, pp. 45, 166, 192, 227, 390 (1927); vol. 8, pp. 8, 18, 36 117, 235–236 (1928).

Calif. State Dept. Agr., *Mthly. Bul.*, vol. 12, pp. 356–363 (1923); *Proc. 6th Conv. Western Plant Quar. Bd.*, p. 54 (1925).

Essig, E. O., *Insects Western No. Am.*, p. 501, fig. 409 (1926).

[455] Campbell, Roy E., *Jour. Econ. Entom.*, vol. 17, pp. 645–647 (1924). Also see references to *Insect Pest Survey Bulletin* above.

[456] See references to *Insect Pest Survey Bulletin* above.

it was known to occur in the following counties in California: Orange, Los Angeles, San Diego, Riverside, San Bernardino, and Ventura. On February 28, 1928, Elmore found adults passing the winter on nightshade in Los Angeles and Orange counties.[457]

In the summer of 1927 it was taken at Douglas, Arizona.[458] Specimens taken there in September by H. Letcher were received by me.

Due to the continued efforts of Campbell, Elmore, and Davis successful commercial control has been developed through the use of arsenate of lead sprays, improved cultural methods and quick maturing varieties of peppers.

According to A. C. Davis, *A. eugenii* Cano interbreeds with *A. solani* Fall. The latter as well as *A. æneolus* Dietz also feed on nightshade in southern California.

The plum curculio, *Conotrachelus nenuphar* (Hbst.), was early feared by the fruit growers of California. In 1879 it was erroneously reported as occurring in the state.[459] In 1882 a resolution was adopted by the Board of State Horticultural Commissioners to take necessary measures to prevent the introduction of this pest into the state.[460] So far they have been successful, for no living specimens have ever reached the Pacific Coast.

DIPTERA (Order)

Flies

CULICIDÆ (Family). Mosquitoes.

Mosquitoes were so common throughout the whole civilized world that little or no mention was made of them by any of the early travelers or settlers in California. I have wondered how the travelers could have traversed the salt marshes about the San Francisco Bay en route by rowboat to the missions Santa Clara, San José, and San Rafael, during the warm summer and fall evenings, without saying a word about the large brown salt marsh mosquito, *Aëdes dorsalis* (Meigen). And how could the miners tolerate the snow mosquito, *A. communis* (De Geer), without some poetic complaint? Certainly there is every reason to believe

457 *Insect Pest Surv. Bul.*, vol. 8, pp. 36, 117 (1928).
458 *Ibid.*, vol. 7, p. 390 (1927).
459 *Pacific Rural Press*, vol. 18, p. 168 (Sept. 13, 1879).
460 Board of State Hort. Commrs. of Calif., *First Rept.*, p. 49 (1882).

that the former was even more numerous in early days, when the marshes of the San Francisco Bay region and the overflow lands and sloughs, along the rivers, were of much greater extent than now.

The general belief has been that, although the malarial mosquitoes, *Anopheles punctipennis* (Say), *A. pseudopunctipennis* Theobald, and *A. maculipennis* Meigen (Figs. 84, 85), were all indigenous, the organism causing malaria was introduced during the gold rush sometime about 1850.[461] It was, however, brought in much earlier, because it is stated Emmons and his party entering California in 1841 from Oregon " finally found themselves upon the great upland plains around Mount Shasta.

" Though harassed by sickness, *chiefly malaria*, and menaced by hostile Indians, Emmons next explored the courses of the Klamath and Rogue Rivers." [462] In October he camped in the upper reaches of the Sacramento Valley and arrived at Sutter's Fort on October 17, 1841. He then moved on to San Francisco. Thus this party left malaria throughout the full length of the Sacramento Valley. New reservoirs of the disease came from all parts of the world during the gold rush so that no region, where the disease could exist, was spared. J. Praslow,[463] a celebrated German physician, who visited California in 1857, states that all types of the disease were well established then.

In the light of the present knowledge of malaria in California today, S. B. Freeborn has interpreted Praslow's remarks as follows: " It (malaria) occurred sparsely in the south, except at scattered points along the coast where light cases were reported, and seldom in San Francisco. The real endemic centers seemed to be the ends of the ' so-called valleys (*Kessels*) ' (San Joaquin and Sacramento). He says that the prevailing type is *tertian*, which is easily cured, that *quotidian* is seldom seen and that one frequently sees cases of *quartan*. His terms of course refer to the occurrence of the

[461] Ebright, Geo. E., Commonwealth Club of California, *Trans.*, vol. 11, p. 3 (1926).

[462] Cleland, R. G., *A History of California, American Period* (N. Y., Macmillan Company, 1922), p. 129.

[463] *Der Staat California in Medicinisch-Geographischer Hinsicht.* (Göttingen, 1857), p. 44. Intermittens,—"Am gewöhnlichsten hat das Fieber die Tertianform und diese sind verhältnissmässig diejenigen, die am schnellsten heilen. Die quotidiane Form ist im Ganzen selten, etwas häufiger findet man Quartan-Fieber. Während die leichteren Formen mit Tertian-Typhus das ganze Jahr hindurch in wechselnder Stärke vorkommen, treten die intensivern und hartnäckigen Fälle im Juli, August und September auf," etc.

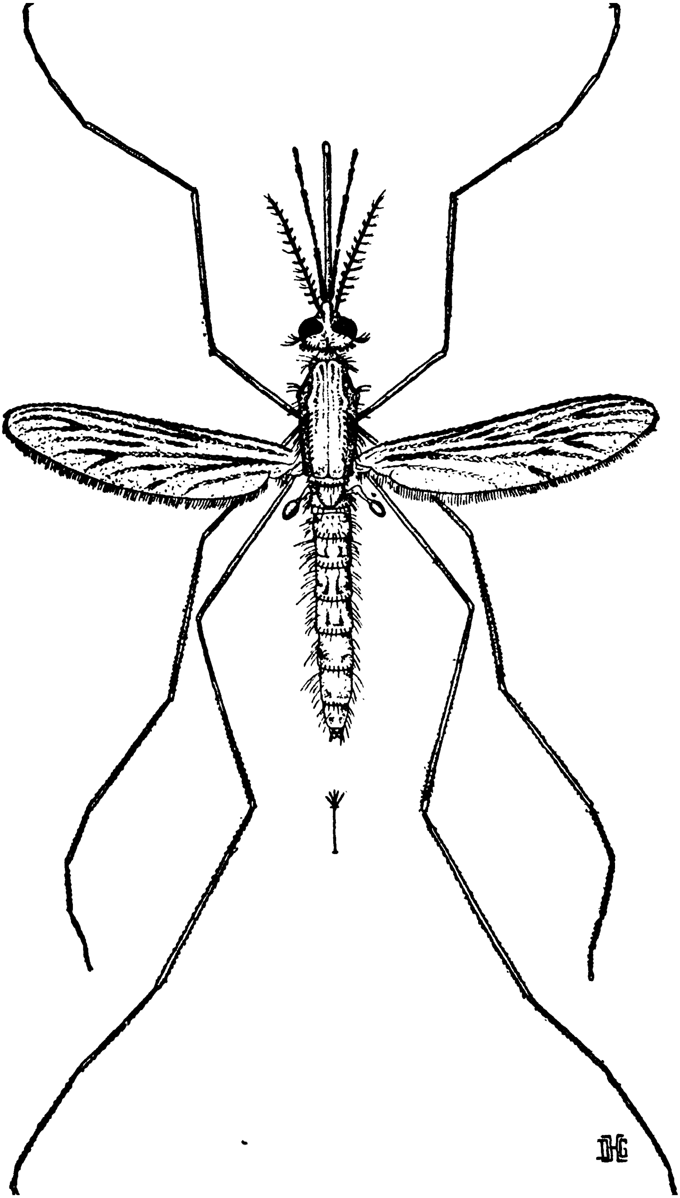

Fig. 84.—The European malarial mosquito, *Anopheles maculipennis* Meigen, is also indigenous to Boreal North America and was present in California before the introduction of the plasmodium causing malaria. The disease appeared in the state sometime during the Spanish or Mexican periods prior to 1841. Adult female. (Redrawn to show more pronounced mottling of the wings from G. H. F. Nuttall and A. E. Shipley, 1901.)

paroxysms and not to the species of the parasites. He then mentions a most interesting fact; that *tertian*, particularly in the above mentioned *'tiefergelegenen Theile des sogenannten Kessels,'* was followed by an intensive and stubborn form of the fever which occurred in July, August, and September. This pernicious form he describes in detail with its many varied symptoms and its continued fever, and remarks that he has seen it many times on the Isthmus of Panama. There is little room to doubt that Praslow saw and described what we recognize now as the *æstivo-autumnal* or *subtertian* malaria." The prevailing belief has been that this type of malaria was not introduced into California until the completion of the transcontinental railroad in 1869–1870, whereas in reality it existed for at least twelve years before that time. The disease was apparently unusually serious in the gold regions of the Sierra foothills during the years 1850, 1852, and 1858. The development of extensive irrigation projects throughout the great interior valleys had a marked influence on increasing malaria, inasmuch as the leaks in the ditches and canals and the extravagant use of water often furnished ideal breeding places for the malaria mosquitoes. The curbing and control of the disease soon became urgent with the result that many districts of the state have conducted, for many years, rigorous and effective campaigns which have afforded complete control.

The first mosquito control campaign in California was inaugurated at Burlingame, San Mateo County, in 1905 under the direction of H. J. Quayle,[464] which involved only the troublesome salt marsh species and had nothing to do with malaria. The first anti-malarial mosquito organization was affected at Penryn, Placer County, February 12, 1910, and the second known as the "Oroville Anti-Mosquito League" at Oroville, Butte County, March 14, 1910. Both of these organizations were due to the untiring efforts of W. B. Herms, who has since then been the leader in the attempts to reduce and control malaria in the state.

In 1916 it was "estimated by the State Board of Health that the cost each year to the state from malaria directly and indirectly to health, labor and property values is $2,820,000," [465] to say nothing about the suffering occasioned by it.

[464] *Mosquito Control*, Calif. Agr. Expt. Sta., Bul. 178, 55 pp., 33 figs. (1906).

[465] Ebright, Geo. E., Commonwealth Club of California, *Trans.*, vol. 11, p. 4 (1916).

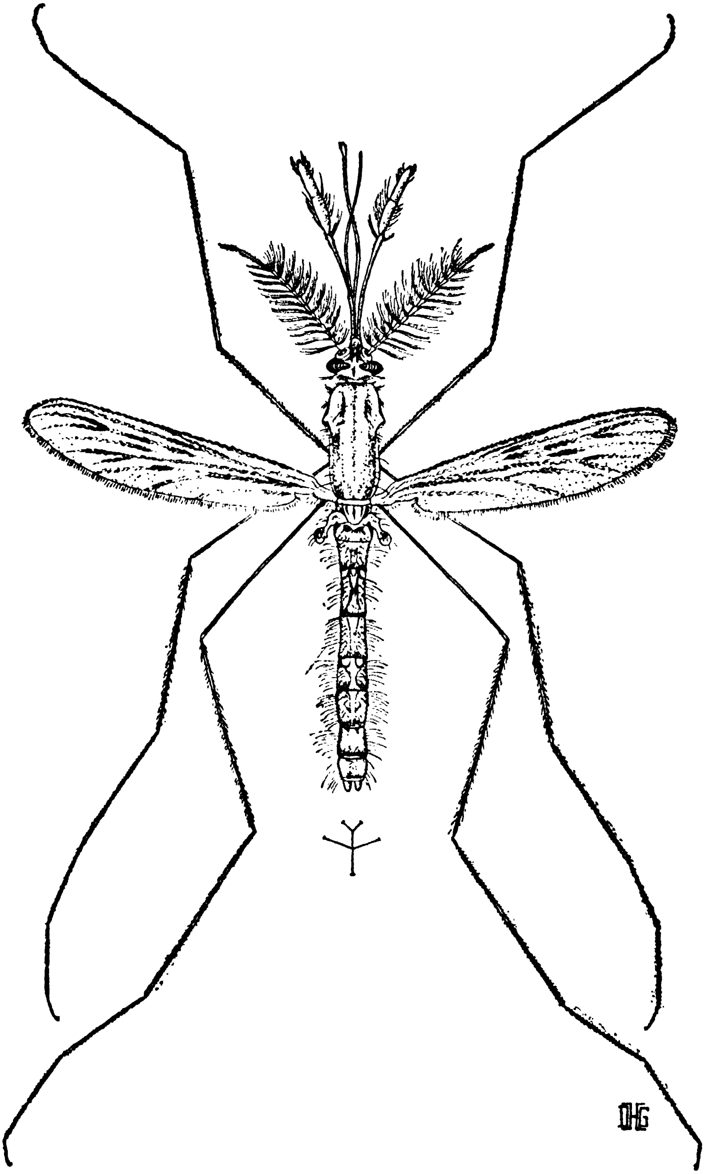

FIG. 85.—The adult male of the European malarial mosquito, *Anopheles maculipennis* Meigen. In contrast to the females the males do not torment mankind. (Redrawn from G. H. F. Nuttall and A. E. Shipley, 1901.)

To determine the distribution of the malarial mosquitoes a survey was financed by the State Board of Health. The survey was undertaken by Herms, who was assisted by S. B. Freeborn and students. Northern California was mapped during the summer of 1916 [466] and central and southern California in 1917,[467] but the complete survey was not completed until 1919.

The state legislature in 1915 passed an act providing for the formation and organization of tax districts to be known as Mosquito Abatement Districts. San Rafael District, Marin County, organized the first district under this act, November 3, 1915. The Three Cities Mosquito Abatement District in San Mateo County followed December 20, 1915. Bakersfield, the first fresh water district, was formed July 18, 1916. At the present time there are seventeen such districts, most of which are anti-malarial in objective. The formation of these abatement districts [468] have largely eliminated the dreaded scourge, malaria, and have greatly improved agricultural conditions in the once malaria-infested areas.

CECIDOMYIIDÆ (Family). Gall Flies, Gall Midges, Gall Gnats.

The Hessian fly,[469] *Phytophaga destructor* (Say), was first observed in California in 1879 and again in 1885 [470] by E. J. Wickson, who reported a serious infestation in experimental plots of wheat at Berkeley, and discussed resistant varieties of wheat as a means of controlling it. In summing up his tests in 1886 Wickson states: "The Hessian fly has but recently been demonstrated to have secured lodgment in California, and its ravages have thus far been confined to valleys adjacent to the San Francisco Bay and its tributaries. It is a question how far its area may extend, but it is highly doubtful if it can thrive in the dry and hot interior valleys. It has been claimed that the practice of burning off the stubble is to be credited with the long freedom of California from the pest. Such practice is certainly to be commended as at least likely to reduce the infliction. In badly infested localities this will not, however, accomplish the dislodgment of the insect, and it may

[466] Herms, W. B., *Jour. Econ. Entom.*, vol. 10, pp. 359–370 (1917); U. S. Pub. Health Service, *Public Health Repts.*, pp. 1579–1587 (July 18, 1919).

[467] Herms, W. B., Calif. State Board of Health, *Mthly. Bulletin*, pp. 211–216 (January, 1920).

[468] *Mosquito abatement districts in California*, Calif. State Bd. of Health, Mthly. Bul., vol. 13, no. 10, pp. 455 (Apr., 1918).

[469] *Pacific Rural Press*, vol. 57, p. 386 (1899).

[470] Calif. Agr. Exp. Sta., *Bul. 56* (1886); *Bul. 58* (1886).

be that the growing of resistant varieties will be of great advantage."

Woodworth [471] also reported it abundant and destructive at Berkeley in 1885. It was afterwards noted at Salinas and in the central part of the state in 1899, and, although it was observed in other localities in the years that followed, it received little or no further note until it was reported abundant in Solano County in 1915. Following this outbreak, studies on the insect in California were begun by T. D. Urbahns in 1916 and completed by C. M. Packard in 1928.

During the years that have followed, this insect has been present in the wheat fields adjacent to the San Francisco Bay region and inland into Yolo and San Joaquin counties. Although never so serious as east of the Rocky Mountains, it has been responsible for a far greater amount of damage than has been accredited to it. Judging from its past history and from the fact that wheat growing is rapidly diminishing in the known infested areas, it is not likely ever to become of great consequence in California.

In 1928, C. M. Packard published a bulletin [472] in which he gave all of the important information regarding the full status of this insect in California at that time.

Some of the main points in Packard's work on the Hessian fly in California are as follows:

1. The insect is of economic importance only in the wheat-growing regions near the coast. (Where little wheat is now grown.)
2. The distribution is given as follows: the insect present, but never abundant, in the counties of Butte, Tehama, Yuba, Sutter, Placer, Yolo, Sacramento, and Stanislaus. Abundant in the counties of Sonoma, Napa, Solano, Marin, San Joaquin, Contra Costa, Alameda, Santa Clara, Santa Cruz, Monterey, San Mateo, and San Francisco.
3. Seasonal history—pupæ present in June to January. Adults issue in February and March and lay eggs on leaves in March and April. Larvæ hatch in May and pupate in June.
4. Six hymenopterous parasites were reared, but were of no economic importance.

In 1922, 527 adults of the eastern parasite, *Platygaster vernalis* Myers, were secured in Indiana and liberated at Birds Landing, California. In the spring of 1925 an additional 2,000 adults were

[471] Woodworth, C. W., Calif. Agr. Expt. Sta., *Rept.*, 1890, pp. 312–318 (1891).
[472] *The Hessian Fly in California*, U. S. Dept. Agr., Tech. Bul. 81, 25 pp., 2 figs. (Nov., 1928).

liberated. However, no traces of the parasite were found in subsequent investigations.

OSCINIDÆ (Family). Frit Flies, Grass-Stem Maggots.

The hippelates fly, *Cadrema pusio* (Loew) (*Hippelates*), belonging to the Oscinidæ, was described by Loew [473] in 1870 from specimens taken in Texas. In July, 1894, Schwarz [474] encountered a plague of hippelates flies at Crescent City, Florida, and referred to a serious disease of the eyelid known as 'sore eye.' [475] In this article he also refers to *H. pusio* Loew. In 1900 Coquillett [476] gave the distribution of the latter as Porto Rico and from Texas north to New Bedford, Massachusetts.

On February 14, 1925, Elizabeth C. Moore, Indio, California, wrote the University of California as follows:

> The last five or six years we have had a regular pest of *gnats*. We never had them before. I know, for I have lived here for twenty-six years. We do not know where the gnats come from nor what to do to destroy them. According to other residents the fly was first noted about 1912, but did not become troublesome until 1920. On November 13, 1925, W. S. Myers of the same city in requesting someone from the University to investigate the matter wrote: We are absolutely at a loss as what to do, and the situation, in my judgment is really a very serious one. Our children are frequently troubled with pink eye, which I am personally inclined to think is caused by the great number of gnats which fill the air, and I know from experience that when one gets into the eye it is a very painful matter.

This was the beginning of a general agitation which soon resulted in a survey of the situation by W. B. Herms and other members of the staff of the Division of Entomology and Parasitology, University of California. It was found that the claims were not overstated, that the fly did occur in great numbers in the Coachella Valley and Imperial Valley and that it was responsible for carrying the so-called pink eye disease in those localities. On May 20, 1926, a petition, originating at Thermal, and signed by twenty-one residents of the Coachella and Imperial valleys, and addressed to the University of California, urgently requested assistance in the control of the pest. In June headquarters were established near

[473] Loew, H., *Centuries of North American Diptera*, vol. 10, p. 87 (1870).

[474] Schwarz, E. A., *The Hippelates plague in Florida*, Insect Life, vol. 7, pp. 374–379, figs. 37–38 (1895).

[475] The species in Florida was determined as *Hippelates flavipes* Loew. Another Texas species noted was *H. plebejus* Loew.

[476] Coquillett, D. W., *Proc. U. S. Nat. Mus.*, vol. 22, p. 265 (1900).

Coachella by Herms and investigations were begun, particularly on the life history of the fly. The first results of these investigations were published by Herms [477] in 1926. The medical aspects of the problem were published in 1927 by Schneider,[478] who designated the pink eye disease as Coachellan pseudo-trachoma, and urged a " thorough study of the primary cause and the ways and means of controlling or eradicating the carriers." On May 19, 1927, J. M. Aldrich determined the fly as *Hippelates pusio* Loew.

In order to properly finance and conduct the apparently extensive investigations necessary to solve what proved to be a stubborn problem, an abatement district was organized and established March 15, 1928.[479]

During the entomological investigations in the Coachella Valley, a temporary laboratory was built and under the direct charge of Herms, visits and short studies were also made by S. B. Freeborn, E. C. Van Dyke, C. W. Woodworth, R. E. Barrett, W. C. Beckley and others.[480]

In April, 1928, D. C. Parman, assistant entomologist, Bureau of Entomology, was stationed in the Coachella Valley to investigate the possibilities of trapping the flies.

After the formation of the abatement district in May, 1915, R. W. Burgess was placed in direct charge of the work as entomologist of the Coachella Valley Abatement District. In March, 1929, an appropriation of $12,000 was made to enable the Bureau of Entomology to study the hippelates fly problem.[481] Parman and Burgess then began extensive trapping experiments. A serious outbreak of trachoma and conjunctivitis was again experienced in the Coachella Valley in March, 1929, and up to that time the immature stages and life history of the fly had not been discovered.

As a result of the trapping experiments Burgess discovered the eggs of hippelates in the middle of May, 1929, and thereafter frequently secured them. With these, larvæ were reared, and life history studies are now under way. It is expected that when the breeding habits are known that control measures may be dis-

[477] Herms, W. B., *Hippelates flies and certain other pests of the Coachella Valley, California*, Jour. Econ. Entom., vol. 19, pp. 692–695 (1926).

[478] Schneider, A., *An introductory report on pseudo-trachoma endemic in the Salton Sea region of California*, Medical Sentinel, vol. 35, pp. 154–161 (March, 1927).

[479] Established under the Mosquito Abatement District Act of May 29, 1915.

[480] Herms, W. B., *The Coachella Valley (California) hippelates fly project*, Jour. Econ. Entom., vol. 21, pp. 690–693, pl. 17 (1928).

[481] *Science*, vol. 69, no. 1783, suppl., p. xiv (March 1, 1928).

covered which will remove this serious menace to human health in the present infested areas.

In 1930, D. G. Hall called attention to the fact that Kertesz [482] was the authority for the statement that the genus *Hippelates* Loew, 1863, is replaced by the genus *Cadrema*, Walker, 1860.

AGROMYZIDÆ (Family). Leaf Miners.

The asparagus miner, *Agromyza simplex* Loew (Fig. 86), was first noted on asparagus in 1904 by R. E. Smith [483] who found it well established in the asparagus growing districts of the state at that time. At the same time he also noted the abundance of the asparagus beetle, *Crioceris asparagi* Linn.[484]

In 1922 F. H. Wymore found the miner in large numbers throughout practically all of the asparagus fields in the delta region and in many cases sufficiently abundant and destructive to seriously affect the mature plants.

TRYPETIDÆ (Family). Fruit Flies.

The currant fruit fly, *Epochra canadensis* (Loew),[485] is a native North American insect originally described as *Trypeta canadensis*

[482] Kertesz, C., *Ann. Mus. Nat. Hungary*, vol. 12, p. 674 (1914).
Jour. Econ. Entom., vol. 23, p. 486 (1930).

[483] Calif. Agr. Expt. Sta., *Bul. 165*, p. 96 (1905).

[484] *Ibid.*

[485] Loew, H., *Smiths. Miscl. Coll.*, 256, pt. III, pp. 235–238 (1873). Original description.

Osten Sacken, C. R., *ibid.*, 270, p. 189 (1878).

Gillette, C. P., Colo. Agr. Exp. Sta., *Bul. 19*, pp. 18–20 (1892); Bul. 114, pp. 24–25 (1906).

Gillette, C. P., and List, G. M., *ibid.*, *Bul. 210*, pp. 31–33 (1915).

Harvey, F. L., Maine Agr. Exp. Sta., *Ann. Rept.*, 1895, Pt. II, pp. 111–126, pls. I–II (1895) (First complete study of the insect); *13th Ann. Rept.*, pt. II, Bul. 35, pp. 25–31, 10 figs.; *14th Ann. Rept.*, pp. 127, 130 (1898).

Felt, E. P., *Bul. N. Y. State Mus.*, vol. 5, no. 23, pp. 160–163 (1898); vol. 6, no. 31, p. 591 (1899).

Piper, C. V., and Doane, R. W., Wash. Agr. Exp. Sta., *Bul. 36*, pp. 1–9 (1898).

Fletcher, J., *Trans. Royal Soc. Canada* (2) vol. 5, sect. iv, pp. 223–224 (1899–1900); Central Exp. Farm, Canada, *Bul. 56*, pp. 30–31 (1907).

Cooley, R. A., Mont. Agr. Exp. Sta., *Bul. 23*, pp. 97–98 (1900); *Bul. 51*, pp. 257–258 (1903); *Jour. Econ. Entom.*, vol. 7, pp. 193–195 (1914).

Craw, A., *Pacific Rural Press*, vol. 62, p. 408 (Dec. 28, 1901); Calif. State Bd. Hort., *8th Bien. Rept.*, 1901–1902, p. 189 (1902).

Aldrich, J. M., *Smiths. Miscl. Coll.*, vol. 46, no. 1444, pp. 603–604 (1905). Bibliography.

Johannsen, O. A., *26th Ann. Rept. Me. Agr. Exp. Sta.*, Bul. 177, pp. 36–37 (1910).

Lovett, A. L., *The currant maggot or gooseberry fruit fly*, Ore. Agr. Exp. Sta., Bien. Crop Pest and Hort. Rept., 1911–1912, pp. 135–136 (1912).

Paine, J. H., *The yellow currant fly or gooseberry fruit fly* (Epochra canadensis *Loew*), Psyche, vol. 19, pp. 139–144, pls. I–II (1912).

by Loew in 1873 from a single female specimen collected by S. J. Smith, Norway, Maine, in the collection of C. R. Osten Sacken. It was named *canadensis* on the supposition that it was collected in Canada. In 1883 Saunders,[486] was the first to record its attacks on red and white currants. Gillette [487] in 1891 noted it abundant in Colorado and Weed [488] referred to it in the same year. The first comprehensive paper on the insect was published by Harvey [489] of Maine in 1895. Since that time the fly has been observed in many parts of the United States and Canada where the currant and gooseberries are grown. Severin,[490] who has published the most complete account of this insect in America gives the following distribution: [491]

Canada—Nova Scotia, Prince Edward Island, Ontario, Manitoba, Saskatchewan, Alberta, British Columbia, and Vancouver Island.

United States—Maine, New York, South Dakota, Colorado, Montana, Utah, Idaho, Washington, Oregon, California.[492]

In California Alexander Craw received specimens from Sebastopol, Sonoma County, in June, 1900, where it was reported serious on red currants. This appears to be the first record of the insect in California. In 1912 J. H. Paine gave a splendid account of the fly and its habits in the vicinity of Stanford University, Palo Alto. In

Treherne, R. C., Entom. Soc. Ontario, *43d Ann. Rept.*, 1912, p. 110 (1913); *Proc. Entom. Soc. British Columbia*, no. 4, pp. 27–28 (1914).

Essig, E. O., Calif. State Hort. Com., *Mthly. Bul.*, vol. 2, p. 731 (1913); *Injurious and beneficial insects of California*, ed. 2, pp. 341–343, figs. 340, 341 (1915); *Insects Western North America*, pp. 603–604, 605, 799, figs. 486–487 (1926).

Slingerland, M. V., and Crosby, C. R., *Manual of fruit insects* (New York, Macmillan, 1914), pp. 355–356.

Whitney, L. A., *The yellow currant and gooseberry fruit-fly*, Calif. State Hort. Com., Mthly. Bul., vol. 5, pp. 152–157, figs. 52–56 (1916).

Severin, H. H. P., *The currant fruit fly*, Maine Agr. Exp. Sta., Bul. 264, pp. 177–244, figs. 13–17, 33 tables (1917) (most complete work and bibliography).

Fruit flies of economic importance in California, Calif. State Hort. Com., Mthly. Bul., vol. 7, pp. 201–206, figs. 36–88 (1918).

Mitchener, A. V., *The currant fruit fly,* Epochra canadensis *Loew, in Manitoba*, Entom. Soc. Ontario, 57th Ann. Rept., 1926, pp. 38–41, 1 fig. (1927).

[486] Saunders, W., *Insects injurious to fruits* (Philadelphia, Lippincott, 1883, ed. 2, 1911), pp. 352–353.

[487] Gillette, C. P., Colo. Agr. Exp. Sta., *Bul. 19*, pp. 19–20 (1892).

[488] Weed, C. M., *Insects and insecticides* (Hanover, N. H., 1891), p. 102.

[489] Harvey, F. L., *The currant fly, the gooseberry fly*, Maine Agr. Exp. Sta., Ann. Rept., 1895, pt. II, pp. 111–126, pls. I–II (1895).

[490] Severin, H. H. P., Maine Agr. Exp. Sta., *Bul. 264* (1917).

[491] Severin, H. H. P., Calif. State Hort. Com., *Mthly. Bul.*, vol. 7, p. 201 (1918).

[492] As possible infested states Severin lists New Hampshire, Massachusetts, Rhode Island, Connecticut, Minnesota, and Nevada. As a matter of fact it is likely to be found coextensive with the hosts.

1915 it was known to occur in the San Francisco Bay region and was specially troublesome to red currants in Alameda County and

FIG. 86.—Asparagus stalks showing the characteristic damage caused by the burrows of the maggots of the asparagus miner, *Agromyza simplex* Loew. This eastern insect was first noted as a pest in New York in 1896 and in the asparagus fields of the delta region in California in 1904. (Photograph furnished by F. H. Wymore, 1922.)

gooseberries in Sonoma County, and in Shasta County. In 1917 Severin [493] reported it in the following cities: Anderson, Santa Rosa, San Mateo, Redwood City, Palo Alto, Mountain View, San José, and Watsonville. At the present time (1929) it is known to occur

[493] Severin, H. H. P., Maine Agr. Exp. Sta., *Bul. 264*, p. 180 (1917).

in limited numbers in the following counties: San Francisco, San Mateo, Santa Cruz,[494] Santa Clara, Alameda, Contra Costa, Napa, Sonoma, Marin, and Mendocino.[495]

The walnut husk fly, *Rhagoletis suavis* Loew subspecies *completa* Cresson,[496] (Fig. 87) was first observed at Chino, California, in

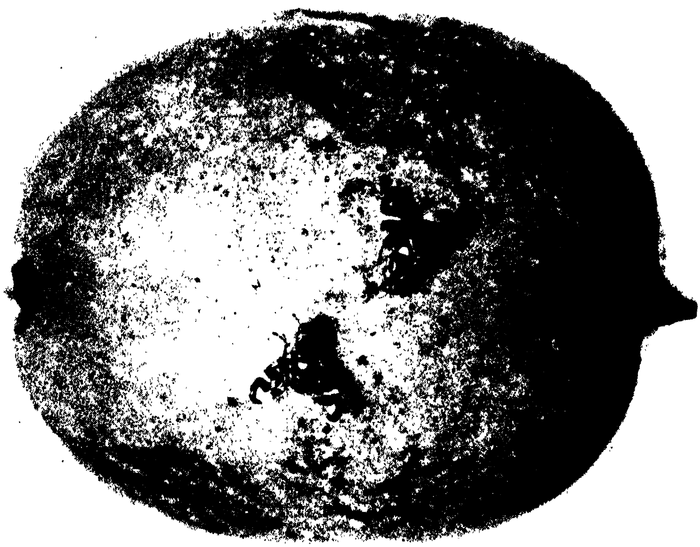

FIG. 87.—The walnut husk fly, *Rhagoletis suavis* Loew subspecies *completa* Cresson. Adult flies on the green husk of an English walnut. This interesting insect is apparently a native of North America and was first noted attacking walnuts in southern California in 1926. (Photograph furnished by A. M. Boyce.)

October, 1926. At that time S. B. Flanders discovered the maggots infesting the green husks of English walnuts. The adults reared from the original material were thought to be the spotted root fly, *Euxesta notata* (Wied.), a common scavenger. The next year adults were again obtained and determined as *Rhagoletis juglandis* Cresson, a species formerly described from Arizona.[497] All of the

[494] Specimens were taken at Santa Cruz in June, 1922.
[495] Specimens were received from Ukiah, May 30, 1922.
[496] I am indebted to A. M. Boyce for the information regarding the synonymy and the citations to the original descriptions of this and related species.
[497] Cresson, E. T., Jr., *Entom. News*, vol. 31, pp. 65–66 (1920).
Essig, E. O., *Insects Western North America*, p. 604 (1926).

early descriptions [498] of the insect in California referred to the fly by this name. Several varieties of the English walnut were infested, but the green husks of the Eureka and Klondike were preferred, and in some cases as high as 90% of the husks were thus injured and 20% of the nuts on some trees were infested in 1928. Because of the reputation of the flies of the family *Trypetidæ*, to which this fly belonged, as potential pests, steps were at once taken to make a complete study of the insect and to attempt the control and eradication of the same. A. M. Boyce, at the Citrus Experiment Station, Riverside, undertook the study of the insect, the results of which were published in 1929.[499] Pest Control Regulation No. 5 was made effective by the State Department of Agriculture, October 30, 1928, and affected the movement of walnuts and sacks out of the infested area in portions of San Bernardino and Los Angeles counties.

The exact synonymy of this fly was definitely cleared up by Cresson [500] in 1929 when he described the California form as a new subspecies.[501]

SIPHONAPTERA (Order). Fleas

Fleas (Figs. 88–91). California has always had a bad reputation for fleas. This is due to the fact that the mild climate permits continuous breeding throughout the entire year and this state is no different in this respect than any other place with a similar climate. The Indian and Spanish houses were literally alive with fleas. Early travelers encountered these conditions wherever they went and published the fact far and wide. It has so far been impossible to find any published records of the exact species of fleas thus found

[498] *Pacific Rural Press*, vol. 116, p. 216 (Sept. 1, 1928).
Calif. State Dept. Agr., *Mthly. Bul.*, vol. 17, p. 472 (1928).
Wolff, K. L., *Calif. Cult.*, vol. 71, pp. 547, 554 (Dec. 1, 1928).
Quayle, H. J., Calif. Agr. Expt. Sta., *Circ. 315*, pp. 15–16, fig. 13 (1929).

[499] *A new pest of English walnuts in California*, Jour. Econ. Entom., vol. 22, pp. 269–270 (1929).
The walnut husk fly, Rhagoletis juglandis *Cresson, ibid.*, vol. 22, pp. 861–866, pl. 26 (1929).

[500] Cresson, E. T., Jr., *Trans. Am. Entom. Soc.*, vol. 55, p. 413 (1929).

[501] The synonymy of the species is as follows:
Trypeta suavis Loew, *Mon. Diptera No. Am.*, pt. 1, p. 75, pl. II, fig. 10 (1862). Middle States.
Acidia suavis Loew, *ibid.*, pt. 3, p. 235, pl. X, fig. 10 (1873).
Rhagoletis suavis (Loew), D. W. Coquillett, *Jour. N. Y. Entom. Soc.*, vol. 7, p. 260 (1899).
Rhagoletis suavis (Loew), G. F. Babb. *Entom. News*, vol. 13, p. 242, pl. XIV (1902). Reared from fruit of black walnut, Amherst, Mass.

in California prior to the American occupation, so I sought the aid of L. O. Howard who with the help of H. E. Ewing kindly furnished the following items:

In a letter dated January 11, 1928, Ewing states:

I have gone over our museum (U. S. National Museum) records of *Pulex irritans* and find that we have five lots from California. They are as follows, arranged chronologically:

In house, Azusa, VII, 23, '94—Coll. L. O. Howard (6317).

On fox, San Diego, Dec., '96—J. O. Snyder.

On black-tailed deer, Humboldt Co., V, 17, '03—H. S. Barber.

On *Felix domestica*, San Francisco, 1907—P. H. Service.

On *Canis familiaris*, San Francisco, Oct., 1907—P. H. Service.

The museum has a large series of this flea representing most of the sections of the United States. It is interesting to note, however, that there are very

FIG. 88.—A flea hunt in an early California lodging house in San Francisco in 1850. (After Rev. Wm. Taylor, 1867.)

few from the northeastern part of the country or from the northwestern part of the same. Most of the records are from the southern states or the southwest.

In regard to the distribution of *Pulex irritans* I might state that we have records in various places in Central and South America, and also have a slide from the Hawaiian Islands.

Howard under date of January 9 and 14, 1928, states:

I first encountered fleas in San Francisco in 1898 and I can testify to the prevalance and rabidness of these animals before the fire.

The old Occidental Hotel used to be badly infested. I visited California

nearly every year from that time until the fire, and the dread of fleas was the only thing that prevented me from joyous anticipations when I started from Washington.

I had been studying fleas a little at that time, and examined the San Francisco specimens under the lens. On account of the unarmed præscutum, I knew that it was not *serraticeps*, and called it *irritans*. Once or twice since then I have referred in correspondence or perhaps in some publication to the fact that I had never seen *irritans* in this country except in California and on one occasion in North Carolina, although I had been very badly punctured by what I took for this species at Oaxaca, Mexico. I have had much experience with *irritans* in Italy, Spain and the south of France, as well as in the Crimea.

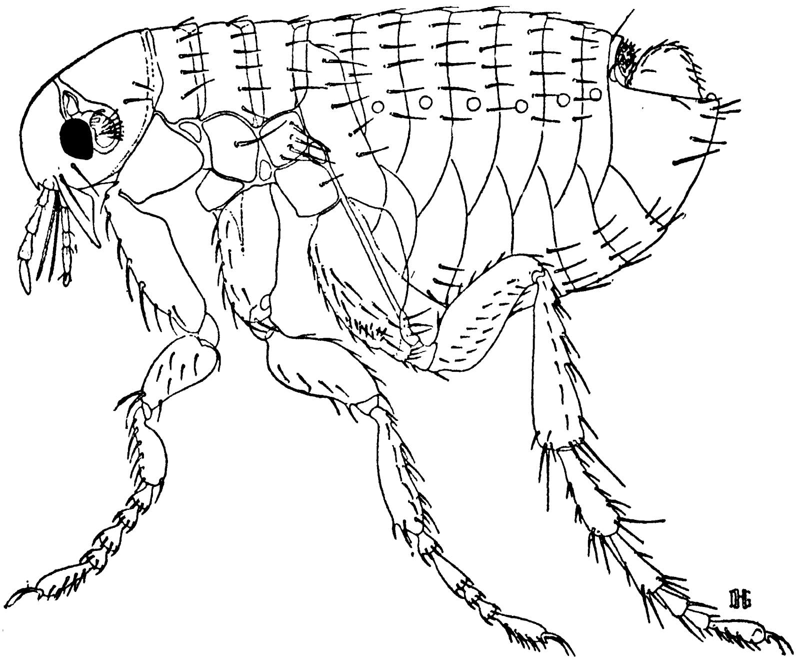

FIG. 89.—The human flea, *Pulex irritans* Linn., a cosmopolitan insect, was either native to or very early introduced into California. It occurred in enormous numbers in the Indian Rancherias and in the Spanish and Mexican settlements and was also the dominant species early contended with by the American settlers and travelers. It is now often replaced by other introduced species, especially in seaport cities.

In this connection, also, R. W. Doane [502] made a study of the fleas collected in San Francisco and other parts in middle California on rats, mice, and humans in 1908. His findings are summarized as follows:

[502] *Notes on fleas collected on rat and human hosts in San Francisco and elsewhere*, Can. Entom., vol. 40, pp. 303–304 (1908).

On rats (*Mus norvegicus*)—	
Ceratophyllus fasciatus	863
Pulex irritans	163
Xenopsylla cheopis (*Lœmopsylla*)	139
Ctenopsyllus musculi	118
Hoplopsyllus anomalus	8
Ctenocephalus canis	9

On humans—	
Pulex irritans	680
Ceratophyllus fasciatus	2
Ceratophyllus sp	2
On mice (*Mus musculus*)—	
Ceratophyllus fasciatus	26
Ctenopsyllus musculi	14
Xenopsylla cheopis (*Lœmopsylla*)	7
On mice (*Microtus californicus*)—	
Ceratophyllus fasciatus	1

From all data available it appears that the species which was so abundant in the early Spanish Missions and ranchos and also in the lodges of the converted Indians was **the human flea,** *Pulex irritans* Linn., (Fig. 89) which is still the dominant species in the state outside of the immediate thickly populated San Francisco Bay region. **The dog flea,** *Ctenocephalus canis* (Curtis), (Fig. 90) appears to have been second in importance in the same areas. If either of these was not native it was introduced at a very early date. Of the two species, the human flea is by far the worst, but there may have been several species in a badly infested habitation. Taylor [503] who was in California during the years of 1849–1850 has given us a good picture of a California lodging room and a few words about fleas.

By way of variety, the adventurous lodgers in those pioneer hotels were frequently visited by the third plague of Egypt, accompanied by a liliputian host of the flea tribe, whose stimulating influence upon their subjects is represented in the accompanying cut. (Fig. 88.) Any man who is not proof against fleas, or who cannot effect a good insurance on his skin, had better keep away from old Spanish towns and Indian villages. When I was at Valparaiso (Chile) I preached for the Rev. Mr. Trumbull; spent an evening in his company, and heard him relate a little of his experience with fleas. Said he: "When I first came to this place I feared the fleas would worry the life out of me. I could neither eat nor sleep, nor stay awake with any comfort. But after a few weeks I got used to them, and now I pay no attention to them. The biting of a dozen at once doesn't cause me to wince, nor lift my pen from the paper."

There seems to have been an impression among these early visitors that one became accustomed to fleas and thereafter paid no further attention to them. This may be true of some individuals, but there are as many others who never become tolerant of their presence, let alone their painful bites. I have always known what

[503] Taylor, Rev. William (London, 1867, Engl. ed.), *California life illustrated.* (There were several earlier American editions.)

they were like, and while their bites were never very painful or poisonous, their very crawling gave me the most annoyance and I never could endure them. To other members of my family fleas could never be tolerated, not even in small numbers, and if there was one in the house, all hands joined in its capture and execution.

The redwoods have always had an unsavory reputation for fleas and old residents used to say that fleas just naturally bred in the

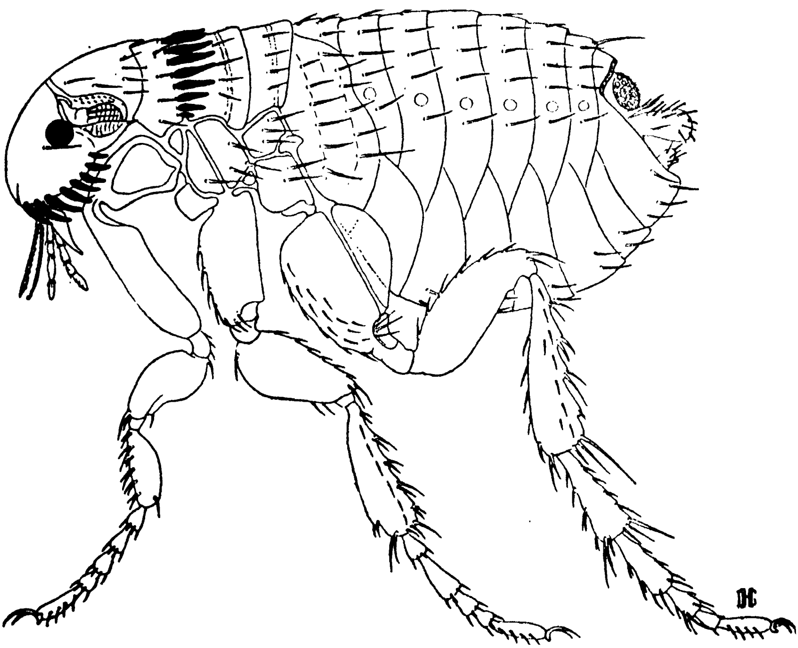

FIG. 90.—The dog flea, *Ctenocephalus canis* (Curtis), also an ancient insect of cosmopolitan distribution, is the second most pestiferous flea in California. It is specially common in the country, but because of the presence of great numbers of dogs and cats in the cities, it is abundant there also. The human flea, dog flea, cat flea, rat fleas, and other species, readily transfer from domestic pets to humans.

bark; and they believed it. I well remember when in the summer of 1902, my father rented the Carr Place on Laribee Creek, near Eel River, in Humboldt County. At that time this ranch consisted of a small clearing of bottom and bench land entirely surrounded by the finest stand of virgin redwood forests in Humboldt County. For many years the place had been used as a hog ranch and former

renters and the swine lived in a more or less communistic fashion. Our first night at this place will always stand out in my mind as a most notable conflict between human beings and fleas. The fleas, however, appeared at first to be the winners. They were in the rooms by the thousands and continued to arrive in army corps through the wide cracks of the floors from under the doors and from " heaven knows where." As soon as the candle was out they were upon us and sleep was not to be thought of. My older brother, who occupied the same bed, had always thought that he was one of those immune individuals, but this time they " took," and he went down with the rest of us. If any one would have suggested to take up thy bed and walk, the fleas would have done it. A tub of water offered the only relief, but as there was but one tub on the ranch, even this was not practical. The warm night, while it was favorable to cold tub baths, only made the fleas the more active and hungry. Fortunately morning came early and we began a thorough and powerful offensive movement against the fleas. It was found that the pigs had been sleeping about and even under the house. They were fenced out and forced to sleep beyond the barn. Everything was raked thoroughly and all the fine refuse burned. The buildings were cleared and everything including the walls and floors of the houses, the ground around and beneath, was thoroughly sprayed with kerosene, distillate, strong soap, and anything of an insecticidal value procurable. As there was no paper on the single walls and no carpets or rugs on the rough floors they were capable of rigorous treatment. The beds were hung on lines and beaten, new straw ticks and fresh sheets provided, and by removing all of our clothes in an outhouse and donning fresh ones for the night, we managed to get along very well. During the day's work our white horse stood in one of the pig's beds at the edge of the woods and the fleas climbed up his legs until they were brown or black from the ground to his belly. He would soon have been a black horse, had not a shower of missils forced him to his heels! We also burned over and sprayed this nest. Wherever pigs sleep, there were the fleas also! and because the farmers in the redwoods usually had hogs they also had fleas. The removal of the former insured the disappearance of the latter, except where dogs were kept.

Wherever sanitary measures are followed, fleas are not at all troublesome in California. In the summer of 1897, A. P. Morse, collecting in California remarks that " fleas are only too common,

but cannot always be caught when desired," [504] which shows that fleas were taken for granted, whether seen or not. During the twelve years we have lived in Berkeley, 1914 to 1927, we have rarely had one in our house. However, two years ago, fleas were observed so abundant about a house in West Berkeley, where a

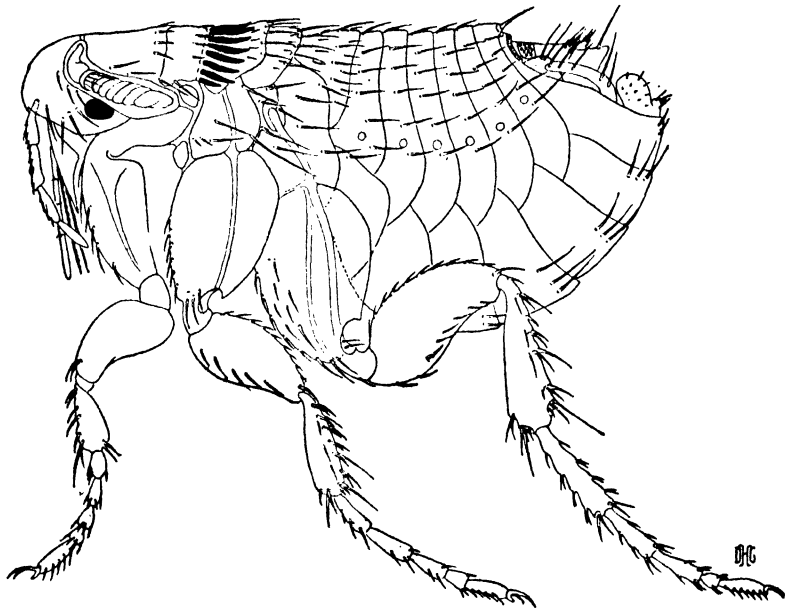

FIG. 91.—The European rat flea, *Ceratophyllus fasciatus* (Bosc), is an introduced species which is now predominant in certain seaport cities in this and other countries. This flea and the Indian or tropical rat flea, *Xenopsylla cheopis* (Roth.), are the important factors in the dissemination of bubonic plague.

large, long-haired dog was allowed to sleep in a shed behind the house, that when looking against the setting sun, they could be seen jumping by thousands—a veritable flea dance!

As a result of immigration and steamship transportation from all parts of the world, **the European rat flea,** *Ceratophyllus fasciatus* (Bosc) (Fig. 91), became firmly established in the seaport cities and is the predominating species on rats in San Francisco and vicinity as clearly shown by the studies made during the plague epidemics in the state. Many of the oriental species of fleas have also been introduced, chiefly into the San Francisco Bay region.

[504] *Psyche*, vol. 8, p. 166 (1898).

These include **the chigoe, jigger or burrowing flea,** *Tunga penetrans* (Linn.), which does not yet appear to be established in the state, **the sticktight flea,** *Echidnophaga gallinacea* (Westwood), not yet abundant, and **the Indian or tropical rat flea,** *Xenopsylla cheopis* (Roth.), which is the most important insect in distributing bubonic plague.

" In addition to the house flea and the cat and dog flea there is at least one other that attacks man in California. It is **the Western chicken flea,** *Ceratophyllus niger* Fox. It was described some years ago from California and is more frequently involved in the attacks of man in the northwest than any other species. I have personally encountered this flea and have been so badly infested that I could get but little sleep for some nights. This flea is restricted entirely to the western part of the United States and does not occur east of the Rocky Mountains and I do not know that it occurs in southern California. It probably is most abundant in Oregon." [505]

Fleas play a most important part in the distribution and persistency of bubonic plague.[506] In California the first outbreak of pneumonic plague was noted in Chinatown, San Francisco, in March, 1900, and persisted until 1905. The second outbreak occurred in San Francisco in May, August, and September, 1907. Since then sporadic cases of plague, consisting of one case each have occurred in California as follows:

Los Angeles	Aug. 11, 1908
Alameda County (rural)	Sept. 24, 1909
Santa Clara County	Aug. 31, 1910

[505] Ewing, H. E., *From a letter dated Jan. 11, 1928.*

[506] Mitzmain, M. B., *Insect transmission of bubonic plague; a study of the San Francisco epidemic*, Entom. News, vol. 19, pp. 353–359 (1908).

Todd, F. M., *Eradicating plague from San Francisco*, Rept. of the Citizens' Health Committee (San Francisco, 1909), 313 pp., 27 figs.

Rucker, W. C., *Fighting an unseen foe*, Sunset, vol. 22, pp. 113–123, 13 figs. (Feb., 1909).

Doane, R. W., *Insects and disease* (New York, Henry Holt & Co., 1910), Fleas and plague, pp. 142–160.

Russ, Raymond, *The story of plague*, Calif. State Bd. Health, Mthly. Bul., vol. 6, pp. 512–518 (1911).

Snow, Wm. F., *The present status of bubonic plague suppression in California*, *ibid.*, vol. 9, pp. 1–12 (1913).

Kellogg, W. H., *An epidemic of pneumonic plague*, Am. Jour. Public Health, vol. 10, pp. 599–605 (1920).

Herms, W. B., *Medical and veterinary entomology* (New York, Macmillan Co., ed. 2, 1923), Plague, pp. 333–346.

Progress report of plague in Los Angeles, Calif. State Bd. Health, Weekly Bul., vol. 3, no. 40, pp. 157–158 (1924).

Fox, Carroll, *Insects and disease of man* (Phila., P. Blakiston's Son & Co., 1925) Plague, pp. 288–314.

Oakland	Aug. 9, 1911
San Joaquin County	Sept. 18, 1911
San Benito County	June 4, 1913
Contra Costa County	July 13, 1915

A small outbreak in Oakland in August and September, 1919, "had its origin in a case of human bubonic plague contracted from a plague infected ground squirrel."

An epidemic occurred in the Mexican quarter of Los Angeles in November, 1924.

It was well known that **the tropical rat flea,** *Xenopsylla cheopis* (Roth.), and **the European rat flea,** *Ceratophyllus fasciatus* (Bosc), were common carriers of the plague germs, and in 1908 it was discovered that **the ground squirrel flea,** *Ceratophyllus acutus* Baker, was also a carrier, and that plague existed endemically among the ground squirrels of the San Francisco Bay region. A campaign for the eradication of ground squirrels in this region was undertaken at once, which resulted in diminution, but not eradication of these rodents.

Concerning them, W. H. Kellogg of the State Board of Health in 1920 [507] writes: "It (plague) persists endemically among these animals, occasionally extending to the human population, usually by way of an epizootic among the rats, but sometimes by direct contact of humans with the wild animals harboring the infection."

In addition to the fleas already mentioned the following species,[508] occurring in California, may also carry plague under certain conditions: **the human flea,** *Pulex irritans* Linn., **the European mouse flea,** *Neopsylla musculi* Duges, **the dog flea,** *Ctenocephalus canis* (Curtis), **the common squirrel flea,** *Hoplopsyllus anomalus* (Baker), and **the cat flea,** *Ctenocephalus felis* (Bouché). The following table [509] gives the percentages of species of 10,972 fleas examined from San Francisco in 1909:

European rat flea	68.07%
Tropical rat flea	21.36%
Human flea	5.57%
European mouse flea	4.48%
Dog flea	.52%

[507] *Op. cit.*, p. 600 (1920).
[508] Bishopp, F. C., Fleas, U. S. Dept. Agr., *Bul. 248*, p. 12 (1915).
[509] From an unpublished MS. thesis by W. C. Rucker (1909). (Chiefly from rats.)

In some sections of old Chinatown, San Francisco, eighty-five per cent taken were the European rat flea and in Oakland, Alameda, and Berkeley as high as ninety-five per cent were of this species, the remainder being mostly the dog flea.[510] In the rural sections of the state the human flea far outnumbers all other species and may occur on humans, dogs, hogs, mice, rats, cats, and other domestic animals and also on skunks, badgers, foxes, coyotes and other wild animals and on poultry and wild birds.

In regard to the seriousness of plague in California, W. H. Kellogg [511] states:

"The pneumonic type of plague is probably not a serious menace on the Pacific Coast, owing to climatic conditions, but could readily become a serious matter in other parts of the United States by extension from the Pacific Coast under the proper climatic conditions."

LEPIDOPTERA (Order). Butterflies and Moths

SATURNIIDÆ (Family). Native Silk Moths.

The silkworm and silk culture. The agitation regarding the rise and decline of silk culture in California is similar to that of its early history in the South Atlantic states. Mulberry culture for the rearing of silkworms was advocated for California at least as early as 1855.[512]

In 1864, the California Legislature, wishing to encourage the silk industry, offered a bounty of two hundred and fifty dollars for every plantation of five thousand mulberry trees of two years' growth, and a bounty of three hundred dollars for each one hundred thousand salable cocoons; and in three years an enormous number of mulberry trees, in various stages of growth, was registered. Prominent among silk-growers (of Southern California) was Louis Prévost, who rather early had established here (Los Angeles) an extensive mulberry tree nursery and near it a large cocoonery for the rearing of silkworms; and had planned, in 1869, the creation of a colony of silkworms whose products would rival even those of his native *belle France*. The California Silk Center Association of Los Angeles was soon formed, and four thousand acres of the *rancho* belonging to Juan Bandini (known as Rubidoux Rancho), fourteen hundred and sixty acres of the Hartshorn Tract and three thousand one hundred and sixty-nine acres of the Jurupa, on the east side of the Santa Ana River (present site of the City of Riverside), were purchased. That was in June or July (1869); but on August 16th, in the midst of a dry season, Louis Prévost died, and the movement received a serious setback.[513]

[510] Mitzmain, M. B., *op. cit.*, p. 354.
[511] *Op. cit.*, p. 605 (1920).
[512] *California Farmer*, vol. 3, p. 58 (Feb. 22, 1855).
[513] "In the summer of 1870, J. W. North of Knoxville, Tennessee, organized

To add to the reverses, the demand for silkworm eggs fell off amazingly; while finally, to give the enterprise its death-blow, the Legislators, fearful that the State Treasury would be depleted through the payment of bounties, withdrew all State aid.[514]

In 1868, according to Cronise,[515] there were then four million mulberry trees, including the white and black varieties, in the state. Whole branches were removed for feeding the worms. Cocoons were of large size and two crops were produced a year. No diseases were present. Eggs from California were sought in France, Italy, and Mexico.

Silk culture received a great impetus in the year 1870 when many advocates were boosting the industry. In that year twelve million cocoons were produced and sericulture was being practiced in Sonoma, Santa Clara, Nevada, Santa Barbara, and Los Angeles counties.[516]

Many articles appeared in the various issues of the Pacific Rural Press and drawings illustrating the life history of the insect appeared on the front page in the issue of May 6, 1871. Numerous advertisements of nurserymen also appeared offering mulberry trees for sale in large or small quantities. Due to the Franco-Prussian War the usual outlet of silkworm eggs from Japan was shifted from France to California and in the spring of 1871, 130,000 cards of eggs valued at five hundred thousand dollars ($500,000) arrived in San Francisco. Some were sent overland through New York to Europe; a large amount was sold in California, and a portion consisting of about ten thousand pounds was lost.[517]

In 1872 various bills providing premiums for silk culture and silk manufacture were again introduced into the State Legislature, but failed.[518] However, the boom went on: orchardists and vineyardists were advised to line the avenues, roads, and property lines with mulberry trees. This was followed to a remarkable degree and mulberries were planted everywhere. As an example the

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the Southern California Colony Association, which took over the whole silk culture tract at $3.50 per acre, and laid out a town, first called *Jurupa* and later changed to Riverside."—Rider's *California*, p. 516 (1925).

[514] Newmark, Harris, *Sixty years in Southern California* (N. Y., Knickerbocker Press, 1916), pp. 390–391.

[515] Cronise, T. F., *The natural wealth of California* (San Francisco, 1868), pp. 393–395.

[516] Hittell, John S., *The resources of California* (San Francisco, 1875, ed. 6), pp. 294–295.

[517] *Pacific Rural Press*, vol. 1, p. 296 (May 13, 1871).

[518] *Ibid.*, vol. 3, p. 121 (Feb. 24, 1872).

Buena Vista Company near Sonoma, owners of the largest vineyard in California, had in addition to the five hundred acres of vines, three thousand mulberry trees. As a result of the boom a considerable amount of very good silk was produced, but it soon became evident that California could not compete in this industry with the well established districts of Asia and southern Europe.

FIG. 92.—The ceanothus silk moth, *Samia euryalus* (Bdv.). Adult male just issued from the cocoon. The large cocoons were used as ritualistic cocoon rattles by the Indians of northwestern California (See Fig. 19). The early sericulturists in California advocated the commercial rearing of this insect as a possible source of silk, until Felix Gillet, in 1879, showed that the cocoons could not be reeled satisfactorily.

By 1876 California's efforts to build up a trade in silkworm eggs was at an end [519] and a general slump in the whole industry soon followed. Some had advocated the rearing of native silkworms, but the impracticability of this was shown by Felix Gillet who demonstrated that the cocoons of the ceanothus silk moth, then called the

[519] *Ibid.*, vol. 11, pp. 274–275 (Apr. 29, 1876).

California lilac moth, *Samia euryalus* (Bdv.) (*S. rubra* Behr) (Fig. 92), could not be reeled satisfactorily.[520] Through all the years which have followed there have always been those who believed this should be a profitable industry in California and have endeavored to prove their position, usually, however, with failure. C. W. Woodworth of the University of California gave a considerable amount of attention to silk culture in California and published a circular [521] on the subject. His findings were entirely contrary to the usual enthusiastic reports of those who were endeavoring to induce others to make trials. Another paper appeared by a Japanese [522] in 1907.

In 1916 Guy Wilkinson purchased 800 acres of land in Butte County and began there a large venture in silk raising under the name Seriterre. He attempted to show that silk could be profitably raised in California. He was thoroughly familiar with the former attempts of silkworm raising in California by Louis Prévost, William Hoag and other pioneers, all of whom failed not because of the difficulty of producing either mulberry leaves or cocoons, but because of the impossibility of establishing in America the cottage industry as practiced in Japan, China, and southern Europe, where limited quantities of silkworms were reared by women and children who gave their undivided days and nights for very small financial returns. Accordingly in the summer of 1917 he sent out an experienced Italian sericulturist throughout the state to locate and mark desirable varieties of mulberry trees. From these trees he obtained sufficient cuttings during the winters of 1917 and 1918 to plant 175,000 trees. Securing some financial aid from a group of business men of the San Francisco Chamber of Commerce, he built a cocoonery 50x120 feet in 1923. Limited by the opinions of his contributors he was unable to order eggs until spring and they arrived too late for successful hatching that year. A small beginning at raising worms was made in 1924, but it was not until 1925 that he was able to operate to capacity when sixty ounces of eggs were hatched. Careful figures were kept of all the operations in the cocoonery and he found that on big scale production a family or group of eight people, including men, women, and children, could

[520] *Ibid.*, vol. 18, p. 305 (Nov. 15, 1879).
[521] *Silk culture*, Calif. Agr. Expt. Sta., Circ. 12, 6 pp. (1904).
[522] Kurosawa, K., *An experiment in rearing silkworms*, Calif. State Com. Hort., Rept., 1905-1906, pp. 261-279 (1907).

handle *sixty* ounces of eggs, whereas in foreign countries they could care for only two ounces. Trays could be cleaned in one and three-fourths minutes, which required forty-five minutes in other countries. Cocoons were raised at a cost of 12.1 cents per pound. In his own words he stated: "Had I given the same attention to the cost of leaf collection I don't know how small a cost production we could have reached." He was seriously handicapped in his work because his financial backers were unable to see the value of a laboratory for the scientific studies and for research work necessary to solve many of the perplexing problems which were quite different from the usual ones met with in old silk-producing countries. Accordingly when he proved to his own satisfaction that silk could be commercially produced in California and had "indisputable cost figures," he quit. Wilkinson believes that many attempts at silk raising in California and elsewhere in this country have been thwarted by silk-importing and foreign producing capitalists, who fear the successful establishment of a silk-producing industry would result in a protective tariff and discrimination against the foreign product.

The American Silk Factories, Inc., bought out the San Diego County Silk Company and began operations at San Marcos in 1928. According to reports [523] the plant was surrounded by 320 acres ready to plant to mulberry trees and that an investment of $350,000 was contemplated. The only assets enumerated were five Burbank mulberry trees valued at $5,000 each, which were said to be the source of buds for "the thousands of trees being planted. The rootstock being used is *Morus alba tatárica*, Siberia . . . about 250,000 trees are now budded, waiting in the nursery row to be set out at the rate of 1,250 trees per acre. A block of 750,000 rootstocks is being brought to San Marcos from a nursery at Marysville. The acreage will be irrigated with an overhead system and water comes 5 miles by a steel line from the Vista Irrigation District main canal.

"The eggs purchased are bred to order in France. They are a hybrid cross between the Yellow Cevenne and White Chinese species. A sufficient shipment is to be sent here each year. The plant started up early in June and expects to produce 150,000 pounds of cocoons by November 1. By 1930 the plans call for

[523] *Pacific Rural Press*, vol. 116, p. 219 (Sept. 1, 1928); *Calif. Cult.*, vol 73, pp. 323 334 (Oct. 5, 1929)

500,000 pounds of cocoons produced between April and November every year.

"The company has enough rootstocks now for planting 1,500 acres, and it plans on establishing additional units in the San Joaquin and Sacramento valleys and maybe elsewhere before long. It is not a stock-selling scheme, but virtually a closed corporation, well financed and ambitious. It is quietly out to make

FIG. 93.—Adults of the meal snout moth, *Pyralis farinalis* Linn. Although this insect has long been known to occur in the United States and in California, it was first noted as a pest of alfalfa hay, in a barn at Colusa, California, in 1929.

money and not to prove to others that they, too, can make silk here. It has no intention of contracting with farmers to grow the mulberry leaf crop for it. It plans to do everything itself, even to selling the products of its own mills."

PYRALIDÆ (Family). Pyralid Moths.

The meal snout moth, *Pyralis farinalis* Linn. (Figs. 93, 94), has for many years been recorded as a pest of cereals and cereal products in California. On April 25, 1929, I first received caterpillars of this moth taken in great numbers in an alfalfa hay barn at Colusa by V. C. Bryant. The larvæ were doing great damage to the hay, particularly around the posts where the straw and refuse were tightly webbed in a felt-like mass. This is the first report of such work so far noted in this state. Adults reared from Colusa were determined by August Busck.

The rice moth, *Aphomia gularis* (Zeller) (*Melissoblaptes, Paralipsa modesta* Butler),[524] is an Asiatic moth described from Japan by Zeller[525] in 1877. It has entered economic entomological literature at a comparatively recent date. Ehrhorn[526] reported it received at Honolulu as follows:

In beans from Guam, 1915.
In rice from Japan, 1916, 1917.
In beans from Japan, 1917; 389 bags infested out of a total of 1,747 bags.
In rice from Manila, 1918.

In October, 1918, E. R. de Ong[527] found a portion of a large lot consisting of about five hundred tons of shelled and unshelled

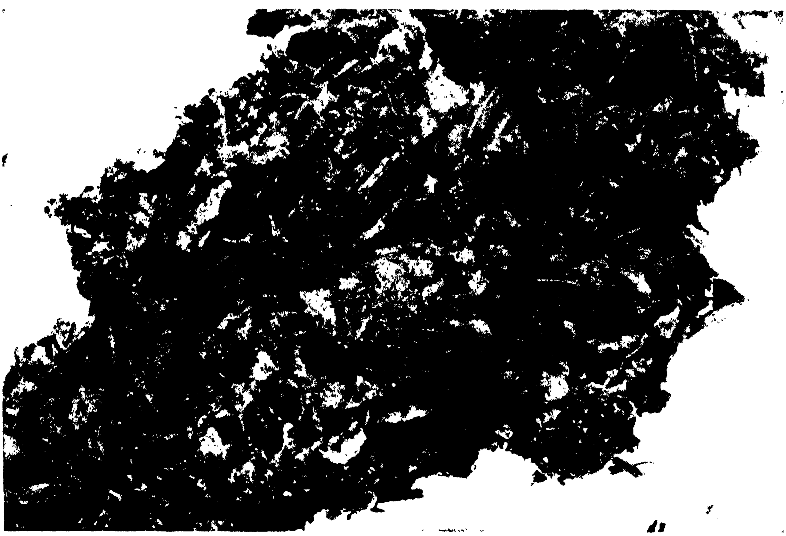

FIG. 94.—Cocoons of the meal snout moth, *Pyralis farinalis* Linn., in alfalfa hay. Exposed pupæ are also visible.

peanuts in a warehouse in San Francisco, California, infested by this insect. Adults were determined by August Busck, who gave the distribution as Japan, China, India, and Vladivostock, Siberia.

[524] Family, Pyralidæ; subfamily, Galleriinæ. Also known as the bean moth.
[525] Zeller, C. P., *Horæ*, Soc. Entom. Ross., vol. 13, p. 74, pl. 1, fig. 26, pl. 2, fig. 27 (1877).
[526] Ehrhorn, E. M., *Hawaiian Forester and Agr.*, vol. 12, pp. 333–336 (1915); vol. 13, pp. 341–343 (1916); vol. 13, pp. 399–401 (1917); vol. 14, pp. 216–218 (1917); vol. 15, pp. 207–209 (1918).
[527] *Jour. Econ. Entom.*, vol. 12, p. 407 (1919).

At that time he supposed it to be a scavenger. This is the first record of the insect in the United States.

In 1922 Laing [528] recorded a shipment of walnuts direct from Marseilles, France [529] to England. The caterpillars had also bored holes into the wooden box containers and were pupating within the same.

On September 21, 1929, I received a lot of prunes infested with a caterpillar from a dried fruit warehouse in San José. A large mass of cocoons were also included. Suspecting these to be of the Indian meal moth, *Plodia interpunctella* (Hbn.), I did not preserve or particularly observe the caterpillars. Later when two adults issued I saw it was something entirely different and forwarded the badly rubbed specimens to Busck who determined them for me and gave *Paralipsa gularis* Zellar as a synonym. Other adults issued from the material later. So far I have had no opportunity to observe the work of the caterpillars and do not know whether they were actually devouring the dried fruit or not.

ÆGERIIDÆ (Family). Clear-Winged Moths.

The Pacific peach tree borer, *Ægeria opalescens* Hy. Edwards, is indigenous to the Pacific Coast region and was described by Henry Edwards [530] in 1881 from three adult males collected at Virginia City, Nevada, by Edwards and a female collected by H. K. Morrison.[531]

Since then adults have been collected at Donner Lake (6,000 feet) and Castello (2,000 feet) by F. X. Williams in 1902 and in the Santa Cruz Mountains in 1905 by J. G. Grundel.[532] The native host appears to be the western chokecherry, *Prunus demissa* (Nutt.). The bitter cherry, *P. emarginata* (Dougl.), and the Sierra plum, *P. subcordata* Benth., may also prove to be hosts as they occur within the natural range of the moth.

Klee [533] appears to have first recorded this insect as a pest in California in 1887. Specimens sent to Riley were described as a new

[528] Laing, F., *Entom. Mthly. Mag.*, vol. 58 (3) vol. 8, p. 191 (1922).

[529] J. de Joannis noted it in France in 1908, *Bul. Mus. Hist. Nat.*, Paris, pp. 277–282, 1 fig. (1908), but it was reported in France earlier.

[530] *Papilio*, vol. 1, p. 199 (1881).

[531] The specimen collected by Morrison is reported from Colorado, but this appears to be an error in locality.

[532] Moulton, D., *The California peach borer*, U. S. Dept. Agr., Bur. Entom., Bul. 97, pt. iv, pp. 66–67 (1911).

[533] Klee, W. G., Calif. State Bd. Hort., *3d Ann. Rept.*, pp. 242–243, 4 figs. (1888); *Pacific Rural Press*, p. 26 (Jan. 12, 1889).

species, *Sannina pacifica* Riley.[534] At that time the insect was reported as preferring peach on peach root stock, but mazzard stock was also infested. The remedy suggested was to wrap the

FIG. 95.—The paradichlorobenzene treatment for the control of the peach borer, *Ægeria exitiosa* Say, originated in the eastern states in 1915. Its use for the control of the Pacific peach tree borer, *A. opalescens* Hy. Edw., was begun in the West in 1921 and has proven very satisfactory. The photograph shows J. B. Hammon demonstrating the method of applying the material to a large apricot tree. (Photograph supplied by J. B. Hammon, 1926.)

base of the tree trunks with stout paper, or paraffin paper and to use air-slaked lime about the base of the tree.

Since these early articles considerable work has been done on the biology and control of this insect pest in California and a number of papers published [535] concerning it.

[534] Riley, C. V., *Insect Life*, vol. 3, p. 393 (1891).

[535] Craw, Alex., Calif. State Bd. Hort., *Bul. 58*, 7 pp., 7 figs. (1891); *Bul. 68* (1894); *Bien. Rept.*, 1895–1896, p. 58 (1896); *Bul. 77* (1900).

Cook, A. J., *Rural Calif.*, p. 436 (Sept., 1895).

Ehrhorn, E. M., *The crown borer of the peach*, Pacific Rural Press, vol. 56, p. 102, fig. (1898); vol. 59, p. 100 (Feb. 17, 1900); vol. 59, p. 132 (March 3, 1900); Calif. State Bd. Hort., *24th Fruit Growers' Conv.*, pp. 139–140 (1899); *8th Bien. Rept.*, 1901–1902, pp. 93–102, 7 figs. (1902); *Rept. 1903–1904*, pp. 113–114 (1904).

Lelong, B. M., and Cooper, E., *Pac. Rural Press*, pp. 146–147 (Aug. 24, 1889).

Lelong, B. M., Calif. State Bd. Hort., *Ann. Rept.*, 1889, p. 229, figs. 87–89 (1890).

Fowler, C., *The peach tree borer*, Rept. Calif. Agr. Expt. Sta., 1898–1901, p. 77 (1902).

Aside from the early practice of digging out the worms and the later use of crude oil, the first real contribution towards the control of this insect was the carbon disulfide treatment recommended by Ehrhorn in 1899 and again by Woodworth in 1902. A better method, consisting of the asphalt treatment, was worked out by Morris in 1908–1912 and published in the latter year. Paradichlorobenzene was tested and proved applicable to the control of the pest in California by Essig in 1921–1926 and results published in October, 1926 (Fig. 95).

At this time the Pacific peach tree borer is known to occur in California, Nevada,[536] Oregon,[537] Washington and British Columbia.[538]

In California it has been noted as a pest only in the following counties: Alameda, Santa Cruz, San Benito, Monterey, Napa, and San Mateo. Supposed single infestations recorded in the Ojai Valley and at Bardsdale in Ventura County and at Banning, Riverside County, in 1914, have not since been noted.

The peach borer, *Ægeria exitiosa* Say, was taken at Dehesa, San Diego County, in 1914 by H. A. Weinland. Adults were reared and positively determined as this species.[539] All infested trees were

Wickson, E. J., *Peach root-borer*, Pacific Rural Press, vol. 55, pp. 277 (Apr. 30, 1898); vol. 56, p. 413 (Dec. 24, 1898).

Woodworth, C. W., *Remedies for peach-tree borer*, *ibid.*, vol. 64, pp. 293–294 (Nov. 8, 1902).

The California peach-tree borer, Calif. Agr. Exp. Sta., Bul. 143, 15 pp., 7 figs. (1902).

Cook, J. O., *Crude oil for peach borer*, Pac. Rural Press, vol. 67, p. 158 (March 5, 1904).

Williams, F. X., *Entom. News*, vol. 20, p. 75 (1909).

Moulton, D., *The California peach borer*, U. S. Dept. Agr., Bur. Entom., Bul. 97, pt. iv, pp. 65–89, fig. 22, pls. viii–x (1911).

Morris, E., *Pear thrips and peach-tree borer*, Calif. Agr. Exp. Sta., Bul. 228, pp. 372–374, figs. 5–6 (1912). Asphaltum treatment.

Essig, E. O., Calif. State Hort. Com., *Inj. and Ben. Ins. Calif.*, pp. 193–195, figs. 180–182 (1913); ed. 2, pp. 422–424, figs. 430–432 (1915); *Insects Western No. Am.*, pp. 722–724, fig. 600 (1926); Calif. Agr. Exp. Sta., *Bul. 411*, 20 pp., 9 figs. (1926). Paradichlorobenzene.

[536] In Nevada this insect has never been of any consequence.

[537] The insect was recorded in Oregon at least as early as 1893.

Allen, E. W., Ore. State Bd. Hort., *Bul. 5*, 2nd Bien. Rept., pp. 67–79, figs. (1893).

Cordley, A. B., Ore. Agr. Expt. Sta., *Press Bul. 1* (Oct. 22, 1896).

Wilson, H. F., and Lovett, A. L., Ore. Agr. Expt. Sta., *Bien. Crop Pest and Hort. Rept.*, 1911–1912, pp. 157–159, fig. 28 (1912).

Lathrop, F. H., and Black, A. B., *The western peach and prune root borer*, *ibid.*, Third Rept., 1915–1920, pp. 59–70, pl. iii (1921).

[538] Eastham, J. W., Dept. Agr., B. C., *Bul. 68* (1916).

[539] Essig, E. O., *Injurious and beneficial insects of California*, ed. 2, pp. 420–421, fig. 429 (1915); *Insects of Western No. Am.*, p. 724, fig. 601 (1926).

destroyed and it appears that the insect was completely eradicated in that locality.

The larvæ of an *Ægeria* species was found infesting young peach trees in a nursery at Compton, Los Angeles County, in 1929.[540] As the stock of these trees was originally received from Iowa it is likely that the insect was the peach borer. However, the entire lot was destroyed and it is believed that the insect was eradicated there also.

The imported currant borer, *Ægeria tipuliformis* (Linn.) (*Sesia*), was introduced into America prior to 1826 and was noted as a pest of currants in Illinois by Walsh [541] in 1866. It has since become the most widely distributed sesiid moth throughout this country—according to Beutenmüller [542] and is to be found in most places where currants and gooseberries are commercially grown. It appears to have been first noted in California in 1880 by C. H. Dwinelle. Since then it is only occasionally met with in the central and northern parts of the state and particularly in the western Sierra foothills.[543] So far it has not proved to be a serious pest anywhere in California. In the west the moth is known to occur in Colorado, Nevada, California, and British Columbia, but probably also occupies some of the intervening territory as well.

The raspberry root borer, *Bembecia marginata* (Harris), is a native American insect described in the genus *Trochilium* by Harris from Massachusetts in 1839 [544] and now extends across the northern portion of the United States and the southern portions of Canada from the Atlantic to the Pacific, where it commonly attacks the roots and crowns of raspberries, blackberries, and loganberries.

In California specimens of adults were collected in Santa Clara County on September 26, 1905.[545] Injury by the larvæ was first noted by the writer in 1916 at Berkeley, Oakland, and Palo Alto and at the present time the moth is known to occur in the counties in the San Francisco Bay region.[546] This insect has also been

[540] Ryan, H. J., Calif. State Dept. Agr., *Mthly. Bul.*, vol. 18, pp. 66–67 (1929).
[541] Walsh, B. D., *Pract. Entom.*, vol. 1, pp. 25–31 (1866).
[542] Beutenmüller, Wm., *Mem. Am. Mus. Nat. Hist.*, i, pt. vi, p. 285 (1901)
[543] Essig, E. O., *Injurious and beneficial insects of California*, pp. 191–193, figs. 178–179 (1913); ed. 2, pp. 427–428, figs. 435–436 (1915); *Insects of Western No. Am.*, pp. 724–725, fig. 602 (1926).
[544] Harris, T. W., *Am. Jour. Arts and Sci.*, vol. 36, p. 309 (1839).
[545] Adults in the collection of the California Academy of Sciences, San Francisco.
[546] Essig, E. O., *Insects of Western North Am.*, pp. 720–721 (1926).

reported from New Mexico, Oregon,[547] Washington,[548] and British Columbia.

The strawberry crown moth,[549] *Synanthedon bibionipennis* (Boisduval) (Fig. 96), has long been known in the west as *Ægeria rutilans* (Hy. Edwards). Its true taxonomy was pointed out in 1928 by Engelhardt,[550] who examined the types in the Barnes' Collection of Lepidoptera. The type of the above is a male "taken in flight in the woods in California by P. J. M. Lorquin sometime between 1852 and 1856 and described as *Sesia bibionipennis*." [551] A male collected on flowers at Los Angeles by Lorquin was described as *S. chrysidipennis* Boisduval.[552]

In 1881 Henry Edwards [553] described this particular moth under the following names:[554]

> *Albuna rutilans* from Virginia City, Nevada (p. 186); *Ægeria lupini* from Marin and Mendocino counties, California (p. 192); *A. impropria* from Marin County and Sierra Nevadas, California and Washington Ty. (p. 193); *A. perplexa* from Texas (pp. 192–193); *A. aureola* from Nevada (p. 194); *A. washingtonia* from Washington Ty. (p. 197); and *A. hemizoniæ* from Nevada (p. 198).

In California this insect has long been known as a pest of strawberries. In 1883 Rivers [555] recorded it as a pest of raspberries at Berkeley, California. In 1888 [556] the same author again reported this insect as injurious to raspberries and blackberries. He gave a good description of the adult female. In the same year Klee [557] recorded it as the strawberry root borer and noted it as doing

[547] Lovett, A. L., Ore. Agr. Exp. Sta., *Third Crop Pest and Hort. Rept.*, 1915–1920, pp. 119–122 (1921). The insect was first noted in Oregon, near Portland, in 1899.

[548] Lawrence, W. H., Wash. Agr. Exp. Sta., *Bul. 63*, 15 pp., 5 figs. (1904).

[549] The common name, strawberry crown borer, has been adopted for the weevil, *Tyloderma fragariæ* Riley, which occurs east of the Rocky Mountains.

[550] Engelhardt, Geo. P., *Boisduval types of Ægeriidæ in the Wm. Barnes collection of N. A. Lepidoptera*, Bul. Brooklyn Entom. Soc., vol. 23, p. 67 (1928).

[551] Boisduval, J. A., *Lépidoptères de la Californie*, Ann. Soc. Entom. Belgique, vol. 12, p. 64, no. 65 (1868–1869). Orig. description.

[552] Boisduval, J. A., *ibid.*, p. 64, no. 64 (1868–1869).

[553] *New genera and species of the family Ægeridæ*, Papilio, vol. 1, pp. 177–208 (1881).

[554] Dyar, H. G., *List of North American Lepidoptera*, U. S. Nat. Mus., Bul. 52, p. 368 (1902).

Barnes, Wm., and McDunnough, J., *Check list of Lepidoptera of Boreal America*, p. 165 (1917).

[555] Rivers, J. J., *Papilio*, vol. 3, p. 26 (1883). *Ægeria hemizoniæ* Hy. Edw. Male.

[556] *Entom. Am.*, vol. 4, p. 99 (1888). *A. impropria* Hy. Edw. Female.

[557] Klee, W. G., Calif. State Bd. Hort., *3d Bien. Rept.*, pp. 243–244, figs. 5–7 (1888).

considerable damage to strawberry plants in various parts of California. He figured the larva, a portion of an infested root with

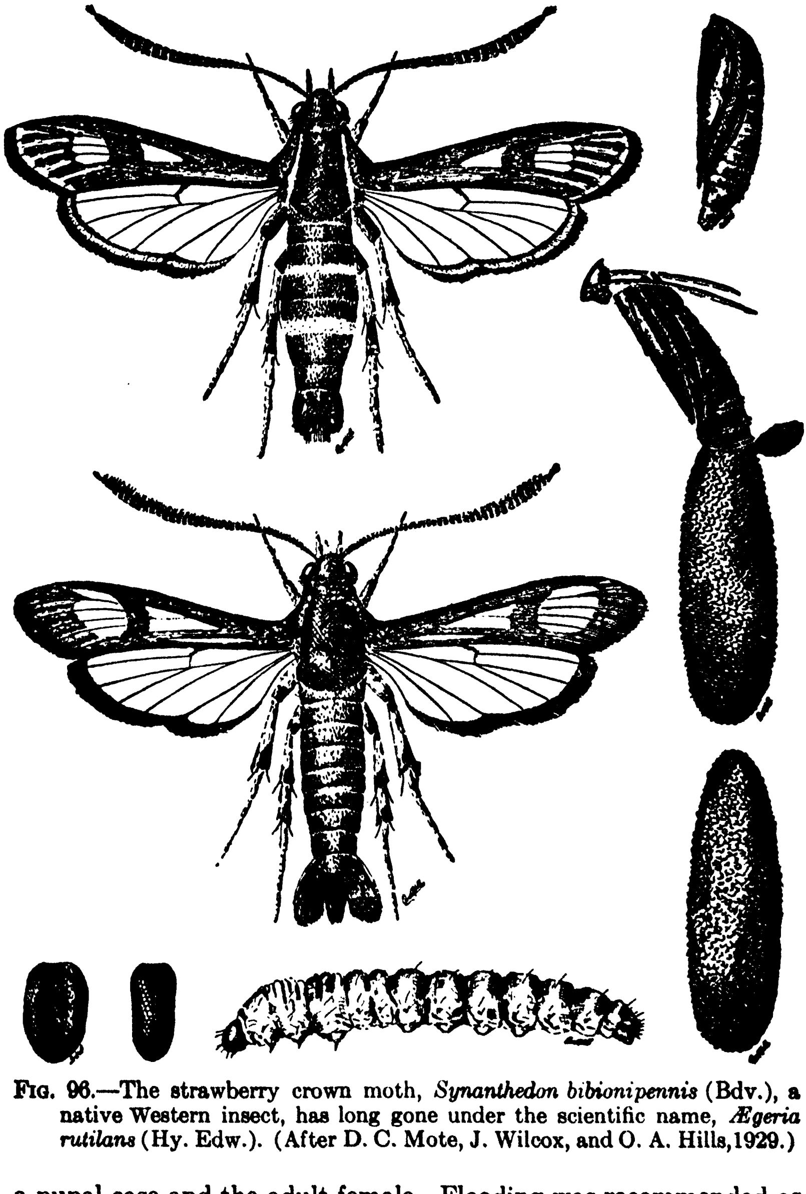

FIG. 96.—The strawberry crown moth, *Synanthedon bibionipennis* (Bdv.), a native Western insect, has long gone under the scientific name, *Ægeria rutilans* (Hy. Edw.). (After D. C. Mote, J. Wilcox, and O. A. Hills, 1929.)

a pupal case and the adult female. Flooding was recommended as a means of control. Since then it has often been reported as a pest

of strawberries, raspberries, and blackberries in the western states.[558]

In 1926 the insect was known to occur in the following states: Texas, Colorado, Utah, Idaho, Nevada, California, Oregon, Washington, and British Columbia.

In 1929, Mote, Wilcox, and Hills[559] gave a splendid account of the biology of this insect in Oregon.

In California at this time the moth is particularly injurious to strawberries which are grown in small backyard patches and which usually suffer for want of food and water. It is rarely a pest in commercial plantings.

OLETHREUTIDÆ (Family).

The codling moth, *Carpocapsa pomonella* (Linn.), is reported to have been introduced into California in 1872 or 1873, but the first conclusive record appears in 1874[560] when the larvæ were observed infesting apples exhibited at the San Joaquin Valley Fair held in Stockton that year. It is, therefore, probable that it was actually introduced several years earlier. In 1876 it was taken in pears at Marysville. In 1875 Matthew Cooke, who under the name of Cooke and Son, operated the Pioneer Box Factory at Sacramento, began the study of insects to inform the public regarding the codling moth which was at that time beginning to interfere with his business as a box manufacturer. A number of articles on this insect appeared under his name in the Pacific Rural Press in 1879 and 1880.[561]

The insect spread rapidly throughout the principal apple growing sections of northern California and created a great deal of concern. In 1881 it was present in the counties of Butte, Sutter, Yuba,

[558] Riley, C. V., *Proc. Entom. Soc. Wash.*, vol. 1, p. 85 (1887).
Piper, C. V., and Doane, R. W., Wash. Agr. Exp. Sta., *Bul. 35*, pp. 13–17 (1898).
Chittenden, F. H., U. S. Dept. Agr., Div. Entom., *Bul. 23* n. s., pp. 85–90, fig. 20 (1900). First complete life history.
Lovett, A. L., *Strawberry crown miner*, Ore. Agr. Exp. Sta., Bien. Crop Pest and Hort. Rept., 1911–1912, pp. 132–133, figs. 14–15 (1912). Ore. State Bd. Hort., *16th Bien. Rept.* (1921).
Essig, E. O., Calif. State Hort. Com., *Injurious and beneficial insects of California*, Mthly. Bul., vol. 1, pp. 190–191, fig. 177 (1913); ed. 2, pp. 425–426, figs. 433–434 (1915).
Essig, E. O., *Insects of Western North America*, pp. 725–726, fig. 603 (1926).
Mote, D. C., Wilcox, J., and Hills, O. A., *The strawberry crown moth in Oregon*, Jour. Econ. Entom., vol. 22, pp. 936–943, fig. 47, pl. 28 (1929). Bibliography.
[559] *Loc. cit.*
[560] *Pacific Rural Press*, vol. 8, p. 264 (Oct. 24, 1874).
[561] *Pacific Rural Press*, vol. 17, p. 81 (Feb. 1), p. 113 (Feb. 15, 1879); vol. 18, p. 40 (July 19, 1879); vol. 19, p. 220 (Apr. 3, 1880).

Colusa, Nevada, Placer, Eldorado, Amador, Sacramento, Yolo, Solano, Napa, Sonoma, Lake, Mendocino, Marin, Contra Costa, Alameda, San Joaquin, Santa Clara, San Mateo, Tuolumne, Calaveras, Tulare, Kern, and Los Angeles.[562] So much was the concern that when the viticultural law was amended in 1883 a

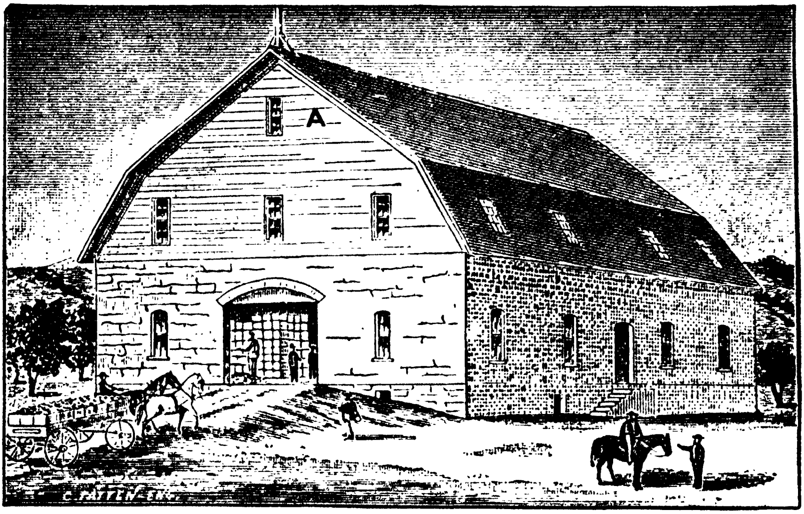

FIG. 97.—The apple storage house of Francis DeLong, Novato Ranch, Marin County, California, in which extensive experiments were conducted in trapping adult codling moths. In the fall of 1882, 15,627 adults were caught and during 1883, 11,974 were trapped. (After Matthew Cooke, 1883. This building still stands in splendid condition.)

Board of State Horticultural Commissioners consisting of 9 members was provided, which board was authorized to appoint a Chief Executive Horticultural and Health Officer at a salary of one hundred and fifty dollars per month with traveling expenses not to exceed five hundred dollars per annum. Matthew Cooke was appointed to fill the position thus created and was expressly charged with the task of controlling the codling moth. Accordingly, he at once formulated the following quarantine regulations which he thought were necessary to cope with the situation.

Quarantine regulations relating to:

1. Examining and disinfecting plant cuttings, scions, plants, trees, etc., imported into the state.
2. Fruit infested with insects or germs.

[562] Cooke, M., *Calif. Fruit Growers' Conv.*, Sacramento, p. 2 (Dec. 6, 1881).

3. Fruit boxes, packages or baskets.
4. Anything likely to carry or harbor insects or germs.
5. Living plant materials to be dipped in a solution composed of 1 pound of concentrated lye to 2 gallons of water.
6. Boxes, packages, and baskets to be dipped for 2 minutes in a boiling solution of 1 pound of lye to 20 gallons of water.

He also formulated 15 rules affecting horticulture, most of which were directed against the codling moth, requiring, among other things:

1. The destruction of the codling moth, its larvæ and pupæ before the first of March each year by
   (1) Scraping the rough bark from the trunks.
   (2) Washing with a disinfectant.
   (3) Disinfecting boxes, storehouses, packing sheds, etc.
   (4) Picking and destroying infested fruit.
   (5) Compulsory banding of trees before May 15th or 30th, and examining bands every 7th day and destroying larvæ or pupæ.
2. To spray trees or plants infested with scale bugs.
3. To spray trees or plants infested with red spider.
4. Dipping boxes returned from market.

S. F. Chapin, member State Board of Horticulture of California, performed some experiments in codling moth control in 1882 [563] in which he banded eight hundred apple and pear trees on July 10 and removed and examined the bands every week, killed the larvæ and replaced the bands. All fallen fruit was carefully gathered and destroyed at short intervals. The work was continued until harvest in October with the following results:

Number of infested fruits picked from trees	1,829
" " " " gathered from ground	1,030
" " " " picked at harvest	200
" " larvæ in fruits picked from trees	834
" " " " " gathered from ground	195
" " " " " picked from trees at harvest	54
" " " taken from the bands	2,552

In all about 825 boxes were involved of which approximately twenty-four and one-half boxes or .0297 per cent were wormy. The cost of placing and caring for the bands and gathering the windfalls amounted to $36.90. A similar experiment begun on May 12, 1883,[564] involving eight hundred and fifty trees, showed the following results:

[563] California Fruit Growers' *Second Ann. Conv.*, San José, Calif., Nov., 1882, pp. 17–20 (1883).
[564] State Bd. Hort., Calif., *Ann. Rept.*, p. 20 (1883).

Number of infested fruits picked from trees to Aug. 28	4,150
" " " " taken from ground by September	2,500
" " " " picked from trees at harvest	20,000
" " larvæ taken in bands	9,852

The loss to the entire crop was nineteen per cent (19%), of which three-fourths occurred during the month of September. The cost of banding was $41.00.

Two spray applications were also recommended by Chapin for the control of the codling moth: a winter spray to be applied in January consisting of one pound of caustic soda to two and one-half gallons of water, and an early summer spray applied when the apples were the size of marbles, and consisting of twenty pounds of whale oil soap, six pounds of sulfur, two pounds of concentrated lye, and forty gallons of water. An orchard thus sprayed, banded and windfalls gathered and destroyed, showed a loss of twenty per cent (20%) in the case of apples and five per cent (5%) in the case of pears.

Chapin [565] and Cooke [566] both cite the experiments of Francis DeLong, Novato, Marin County, in which he screened the windows of a large three-story apple house, 100x70 feet, the lower story of stone twelve feet high, the second story of brick, fourteen feet high, and the third story in the form of a hip roof about twenty feet from the floor to the ridgepole. (Fig. 97.) The object was to trap the codling moth carried to his premises in return packages. In 1882 the house was closed from April 15 to August 28 and 15,627 adult moths were counted. In 1883 the house was closed from April 15 to August 12 and 11,974 moths were trapped. Old as it is, this experiment is an object lesson indicating the necessity of safeguarding against infestations that arise in orchards adjacent to large packing houses, drying houses, and vinegar plants.

Matthew Cooke did not recommend for codling moth the use of the arsenical sprays which were being used experimentally throughout the East at that time. In his book on Injurious Insects of the Orchard, Vineyard, etc.,[567] he recommended as a spray the formula used by Chapin for the fruit and foliage: 1 pound of whale oil soap, $\frac{1}{3}$ pound of sulfur, $1\frac{1}{2}$ ounces of (1 pound of American

[565] Chapin, S. F., California State Fruit Growers' *Second Ann. Conv.*, 1882, p. 21 (1883); State Bd. Hort. Calif., *Ann. Rept.*, pp. 85–86 (1883).

[566] Cooke, Matthew, *Injurious insects of the orchard, vineyard, etc.*, pp. 39–42 (1883).

[567] (Sacramento, H. S. Crocker & Co., 1883), p. 108.

concentrated lye to 1 gallon of water); $1\frac{1}{2}$ ounces of (1 pound of caustic soda, English brand, and 2 ounces of common potash mixed).

FIG. 98.—A. D. Borden hanging a codling moth bait pan in an apple tree at Sebastopol, California, May 4, 1928.

Dissolve in 1 gallon of water and use 4 pounds to each 5 gallons of water; repeat spraying within twenty days.

As late as 1887 there was still much controversy as to whether Paris green, London purple or white arsenic was preferable for the control of the codling moth. Paris green appeared to be favored in the east and was heartily recommended by A. J. Cook of Michigan,

S. A. Forbes of Illinois and others, while C. V. Riley, entomologist for the U. S. Department of Agriculture, at first preferred London purple.

E. J. Wickson [568] in 1887 records a series of experiments supervised by W. A. Klee, in the control of the codling moth in California, in which all of these poisons were used and concluded that white arsenic was least desirable, but that both Paris green and London purple gave satisfactory results. "In the case of Paris green, the application of a wash with one pound of Paris green to 160 gallons of water must be regarded as very satisfactory, giving a gain of over 70 per cent of good apples and pears and not doing any injury to foliage or fruit." He also summarizes the experiments in the use of bands as follows: "It would seem from this experiment (banding 457 trees) that the bands catch less than half the worms which gain access to the fruit, and yet the destruction of this porportion of fully fed and healthy larvæ must be considered very satisfactory."

In 1888 L. O. Howard gave the best historical account of this insect and of the development of control measures published to that date. In this article [569] he gave a review of all the important data for the entire country. In 1902 Slingerland [570] gave a splendid account of the insect as was also the later account of Simpson [571] in 1902.

The codling moth was established in southern California in 1889.[572]

In 1893 Bordeaux mixture was successfully combined with Paris green to control codling moth and apple scab in this state.[573]

C. L. Marlatt of the Bureau of Entomology, U. S. Department of Agriculture, advocated Paris green in 1895 in the following words:[574] "Paris green is the most useful and valuable of the arsenicals used as insecticides. . . . Its use as an insecticide has enormously extended of late years, and upward of 2,000 tons are

[568] Calif. Agr. Expt. Sta., *Bul. 75* (1887).
[569] *The codling moth*, U. S. Dept. Agr., Yearbook, 1887, pp. 88–115 (1888).
[570] Slingerland, M. V., *The codling moth*, Cornell Agr. Exp. Sta., Bul. 142, 69 pp., 21 figs., 1 pl. (1898). Bibliography.
[571] Simpson, C. B., *The codling moth*, U. S. Dept. Agr., Div. Entom., Bul. 41, 105 pp., 19 figs., 16 pls. (1902). Complete Bibliography.
[572] *Calif. Cultivator*, vol. 12, p. 12 (1889).
[573] Calif. State Board of Hort., *Ann. Rept.*, p. 109 (1893–94).
[574] *Insect life*, vol. 7, p. 408 (1895).

annually employed in the United States, besides 400 tons in Canada."

In 1895 the Taft and Kedzie formulas for making arsenite of lime met with considerable favor in parts of the country as home-made substitutes for Paris green. When sufficient lime was used the materials were comparatively safe from foliage injury. (See white arsenic, p. 431.) They were the forerunners of arsenate of lead which entirely replaced all the previously used poison insecticides particularly for codling moth.

In 1904 C. W. Woodworth [575] gave directions for spraying for the codling moth and stated that "Paris green is highly satisfactory wherever it is safe to foliage, but in some localities may have to be replaced by lime arsenite or lead arsenate."

About this time marks the beginning of the use of arsenate of lead for the control of this insect in California. It was soon accepted as a much safer spray than Paris green, which it has entirely replaced. A still milder form designated as neutral or basic arsenate of lead came into use about 1914 and has been generally adopted in the fog belt area of the coast region of California and wherever arsenate of lead is used in combination with lime-sulfur or Bordeaux mixture for the control of the codling moth and other leaf and fruit-eating insects. It is now used extensively in southern California for the control of the codling moth on the English walnut.

In 1923 it was estimated that $1,800,000 was spent for the control of insects attacking apples in California,[576] of which practically all was directed against the codling moth.

Arsenical residue on fruit sprayed for the control of the codling moth, first came into prominence as injurious to public health in a shipment of pears to Boston in 1920.[577] Following condemnations of this fruit, steps were taken to eliminate all possibilities of either apples or pears carrying sufficient poison to injure humans.[578]

Improved methods of spraying were recommended and the quantity of arsenate of lead reduced. In spite of these precautions a few shipments of apples to England were condemned in 1924–

575 Calif. Agr. Exp. Sta., *Bul. 155* (1904).

576 Urbahns, T. D., *Calif. State Dept. Agr.*, Sacramento, Calif. (Dec. 1, 1923).

577 Paris green was detected on apples exported to England from America in December, 1891; *Calif. Fruit Grower*, vol. 10, p. 33 (Jan. 16, 1892), p. 83 (Feb. 6, 1892).

Maynard, S. T., Hatch Exp. Sta., Mass. Agr. College, *Bul. 17*, pp. 39–40 (1892).

578 Calif. State Dept. Agr., *Mthly. Bul.*, vol. 10, pp. 581–582 (1921); vol. 11, pp. 13–28 (1922).

1925 and even more strenuous steps were taken to prevent such residue. In 1926 entomologists of the University of California, State Department of Agriculture and Bureau of Entomology, formulated a set of recommendations for the control of the codling moth and also to meet the arsenical residue problem.

In view of the arsenical residue situation we are again emphasizing the necessity of sanitary measures and banding, materially as formulated by Matthew Cooke with the aim of reducing the numbers of the worms to such a degree that control may be obtained with fewer applications of arsenate of lead.

The 1927 recommendations for codling moth control in the Pacific Coast states include:

1. More attention should be given to first brood worms.
2. The calyx spray is the most important spray in codling moth control.
3. Use standard (acid) arsenate of lead at the rate of two to three pounds of powder or four to six pounds of paste to one hundred gallons of water. In the fog belt use basic arsenate of lead at the rate of four pounds to one hundred gallons of water.
4. Two cover sprays are usually necessary. Later sprays should be made only where infestations are of sufficient importance to warrant further attention.
5. Burlap bands should also be used in connection with other control measures.
6. Other practices include scraping the rough bark from the tree trunks and large limbs; destruction of windfalls; thinning the fruit; packing house and dry yard sanitation; treating boxes, sacks, etc., to destroy hibernating larvæ; destruction of culls and waste products about packing houses, dryers, vinegar factories and similar places.

In 1909 the codling moth assumed a new rôle in California by attacking the green nuts of the English walnut at Concord.[579] This first infestation was of little or no consequence and no further attention was given it. However, in 1913 C. W. Beers,[580] Horticultural Commissioner of Santa Barbara County, discovered a similar attack in that county and it is known to have injured walnuts also in Orange County earlier than 1913.[581] It became evident in the walnut orchards of Ventura County in 1917 and later became distributed also in parts of Los Angeles, San Bernar-

[579] Foster, S. W., *On the nut-feeding habits of the codling moth*, U. S. Dept. Agr., Bur. Entom., Bul. 80, pt. V, pp. 67–70, pls. 7–8 (1910).

[580] Essig, E. O., *Codling moth attacking walnuts*, Calif. Hort. Com., Mthly. Bul., vol. 2, p. 659 (1913).

[581] Quayle, H. J., *The codling moth in walnuts*, Calif. State Dept. of Agr., Mthly. Bul., vol. 9, pp. 64–69 (1920); Calif. Agr. Exp. Sta., *Bul. 402*, 33 pp., 11 figs. (1926).

dino, and Riverside Counties. Its destructiveness to the walnut crop became evident during the years from 1919–1925 [582] and

FIG. 99.—Codling moth bait pan suspended in an apple tree, showing the proper location. The pans are cleaned and refilled at least once a week.

necessitated special spraying and dusting methods in order to adequately treat the large walnut trees. Thorough control has been secured, chiefly through the efforts of H. J. Quayle, by a

[582] The highest infestation during this period was estimated at about 37 per cent by Quayle.

combined program of either dusting or spraying and banding. In 1928 Wright [583] published an extended and complete article on the results of the treatment of the codling moth and aphis on walnuts in Orange County in 1927. While both dusting and spraying gave control, spraying was regarded as the most efficient. As a combination spray for both pests, fifteen pounds of basic arsenate of lead, one pint of forty per cent nicotine sulfate, and three pounds of spreader (casein) to every three hundred gallons of water was recommended. This was for the first treatment and timed according to the season. A follow-up dusting with two per cent nicotine dust was also recommended if necessary for aphis. Burlap bands are also extensively used in connection with codling moth control on walnuts.

During the years 1926–1928 a great deal of investigational and field work was done on the trapping of adult moths with baits (Figs. 98, 99). The baits used consisted of boiled apple juice or molasses syrup, diluted with water and caused to ferment by the addition of yeast cakes. A commonly accepted formula consisted of one part of molasses and nine parts of water. One yeast cake was added to every gallon of this mixture and after fermenting for from twelve to twenty-four hours, the bait was put in shallow enamelware pans which were suspended in the upper portions of the trees, usually one pan to each tree. Recently, Diamalt, 1 pint to 19 pints of water, and 1 yeast cake is used. The pans were refilled at intervals of from three to seven days. The number of female moths collected in these pans was quite remarkable and, besides giving valuable data as to the emergence of the adults, the pans played an important part in the actual control of the pest.

Biological control. An attempt to control the codling moth by natural enemies was made by the State Horticultural Commissioner in 1904–1908. George Compere collected a promising parasite, *Calliephialtes messor* (Grav.),[584] in Spain in 1904. It was reared in great numbers in the State Insectary where it appeared to be exceedingly effective, but when liberated in the orchards it soon became so reduced in numbers as to be of little value, and completely disappeared.

[583] Wright, W. H., *Calif. Cult.*, vol. 70, p. 542 (May 12, 1928).
[584] Cooper, Ellwood, *Family Ichneumonidæ*, Calif. State Commr. Hort., Second Bien. Rept., 1905–1906, pp. 231–235 (1907).
Smith, H. S., and Vosler, E. J., Calif. State Commr. Hort., *Mthly. Bul.*, vol. 3, pp. 195–211 (1914).

In 1928 an experiment was made by S. E. Flanders, then entomologist for the Saticoy Walnut Growers' Association, to artificially rear the minute egg parasite, *Trichogramma minutum* Riley, to destroy the eggs of the codling moth in the walnut orchards of southern California.

By ingenious technique Flanders artificially reared the parasite in enormous numbers, using the eggs of the Angoumois grain moth as a host, and made tests on the control of the codling moth in walnut groves. Numerous entomologists elsewhere in the United States studied Flanders' work at his laboratory and later undertook similar work with *Trichogramma.*

GELECHIIDÆ (Family). Gelechid Moths.

The peach twig borer, *Anarsia lineatella* Zeller (Fig. 100), was observed in many parts of California as early as 1881 [585] and appears to have been officially reported in the state during the next year, 1882, by Matthew Cooke [586] who found the larvæ boring into the fruit of peaches and apricots, and also by C. H. Dwinelle.[587] The next year Cooke received specimens of plums, prunes, and nectarines infested by the larvæ. These first reports did not mention the injury to twigs by the larvæ. Gas lime, which was recommended for so many troubles in 1886, was also suggested as a remedy for this pest as well as to prune out the infested twigs, which were evidently discovered prior to this date. In 1893 E. M. Ehrhorn and Alexander Craw reported the pest in the state [588] and showed that the larvæ passed the winter in minute hibernaculæ in the bark of the crotches of the branches of the trees. The first complete study of the pest was published by C. L. Marlatt in 1898.[589] Due to the ravages of the insect and the lack of adequate means of control, C. W. Woodworth made arrangements with the peach growers of Placer County for coöperative investigations to be undertaken. Work was begun in January, 1902, and the results published in September of the same year.[590] In this

[585] State Bd. Hort. of Calif., *Bien. Rept.*, pp. 29–30, 39–41 (1884).
[586] *Injurious insects of orchard, vineyard, etc.*, pp. 128–129 (1883).
State Bd. of Hort. of Calif., *First Rept.*, pp. 16–17 (1882).
[587] *Ibid.*, pp. 16–17 (1882).
[588] State Bd. Hort. of Calif., Rept. for 1893, *Bul. 67*, p. 9 (1894).
[589] U. S. Dept. Agr., Bur. Entom., *Bul. 10*, n. s. (1898).
[590] Clarke, W. T., *The peach worm*, Calif. Agr. Expt. Sta., Bul. 144, 44 pp., 19 figs. (1902).

bulletin Clarke gave full recommendations for the use of lime-sulfur for the control of the insect and this method of control has remained the standard to this day. In 1921–22 apricot and peach trees, which had been repeatedly sprayed with lime-sulfur for the control of fungous troubles, particularly brown rot and peach blight, as well as for the peach twig borer, began to show signs of serious injury, forced the discontinuance of this spray and the substitution of Bordeaux mixture for the control of the fungous diseases. This left no means of coping with the peach twig borer so W. P. Duruz, University of California, began investigations, not only to find a substitute for lime-sulfur, but also to review the entire spray program for this pest. His results showed [591] that lime-sulfur was a most practical insecticide for the control of this insect and, that where it was thought inadvisable to use this material, that equally good results could be obtained by combining three pounds of powdered basic arsenate of lead with Bordeaux mixture or by using three-fourths pint of 40% nicotine sulfate to 100 gallons of water. In the winter of 1925–26 the peach growers of the Sacramento Valley and adjacent foothill districts continued to use the regular dormant lime-sulfur exclusively, while in the San Joaquin and Santa Clara Valleys, where the lime-sulfur injury was most evident, about half used the lime-sulfur and the other half the combined Bordeaux mixture and basic arsenate of lead with equally good results.

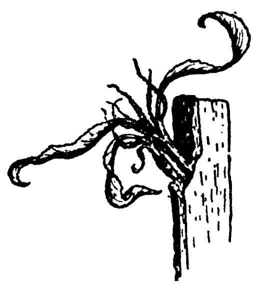

FIG. 100.—A longitudinal section of a young peach shoot showing the burrow of the peach twig borer, *Anarsia lineatella* Zeller. This insect has been an important pest in America since 1860. (One of the original drawings used by W. T. Clarke in 1902.)

The potato tuber moth, *Phthorimæa operculella* Zeller (Fig. 101), was the insect probably referred to in the California Farmer in 1854 [592] as "a coleopterous form which burrows in the eyes and perforates the tuber in all directions." Specimens were taken at Santa Cruz and elsewhere in the state. According to J. E. Graf, William Wood, late horticultural commissioner of Los Angeles County, reported potatoes badly attacked by it in the vicinity of

[591] *The peach twig-borer*, Calif. Agr. Expt. Sta., Bul. 355, pp. 419–464, 16 figs. (1923).
[592] Vol. 1, p. 10 (Jan. 12, 1854).

Whittier in 1874.[593] Specimens of potatoes infested with the larvæ were received by Matthew Cooke [594] in 1881 and 1882. In 1888 specimens of potatoes infested with the larvæ were purchased in the market at Los Angeles by W. L. Drew,[595] and in 1891 the pest was taken at Bakersfield.[596] In 1901 W. T. Clarke published a bulletin [597] in which all the information concerning the insect at that time was given and was the first complete treatise published in this country. The insect was considered the most serious pest of potatoes in California at that time and still holds first place in this respect. In 1912 the writer prepared an article on this same pest,[598] in

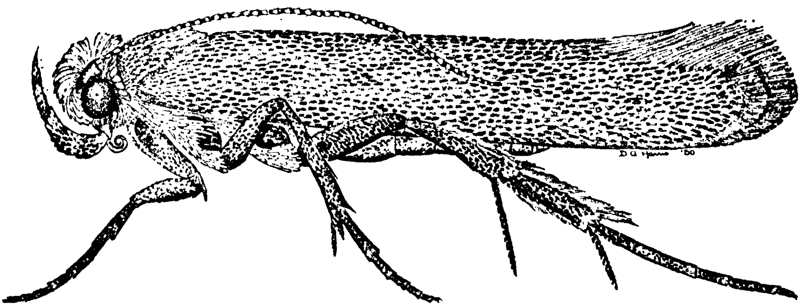

FIG. 101.—The potato tuber moth, *Phthorimæa operculella* (Zeller). Adult. This important insect appears to have been introduced into California at an early date, perhaps prior to 1854. It was a pest in southern California in 1874.

which the distribution covered practically all the potato-growing sections of the state excepting the coast counties north of San Francisco Bay. Control measures were also given. The most extensive paper was prepared by J. E. Graf, when entomological assistant for the Bureau of Entomology, which appeared in 1917.[599] The distribution in California at that time included the counties of Alameda, Contra Costa, Eldorado, Kern, Los Angeles, Modoc, Monterey, Napa, Orange, Riverside, Sacramento, San Benito, San Bernardino, Santa Clara, Santa Cruz, San Diego, San Joaquin, San Luis Obispo, Shasta, Sonoma, Stanislaus, Ventura, and Yolo. Due to

593 U. S. Dept. Agr., Bur. Entom., *Bul. 427* (Prof. paper), p. 2 (Feb. 6, 1917).
594 *Injurious insects of the orchard, vineyard, etc.*, p. 313 (1883).
595 *Insect Life*, vol. 4, p. 396 (1892).
596 *Ibid.*, vol. 4, p. 241 (1892).
597 Calif. Agr. Expt. Sta., *Bul. 135*, 30 pp., 10 figs. (1901).
598 Essig, E. O., Calif. State Comm. Hort., *Mthly. Bul.*, vol. 1, pp. 203-213 (1912).
599 U. S. Dept. Agr., Bur. Entom., *Bul. 427* (Prof. paper), 56 pp., 45 figs., 1 map (1917).

certain quarantine restrictions placed on potatoes grown in California by the states of Oregon, Washington, and Idaho, because of the danger of introducing the potato tuber moth, the State Department of Agriculture, Sacramento, issued a statement entitled "Suggestions for controlling tuber moth in potatoes, with special reference to standardization and grading," [600] the object of which was to insure the shipment of only clean potatoes to these and other states.

Experience shows that this insect is peculiar in that it thrives best under dry, hot conditions and does not appear to make any headway in districts which are cold and wet during the winter.

HYMENOPTERA (Order)

Sawflies, Gallflies, Ants, Wasps, Bees, etc.

TENTHREDINIDÆ (Family). Sawflies.

The California pear sawfly, *Diphadnus californicus* (Marlatt),[601] was originally figured and recorded as *Nematus similaris* (Norton) by Matthew Cooke in 1881.[602] In that year as well as in 1880 the small green larvæ were abundant in pear orchards in several counties in central California. One Winter Nelis tree was stripped of its foliage in 1880. Since then the insect has been noticed regularly in pear orchards in the Sacramento Valley and in the San Francisco Bay region, California, where it is seldom sufficiently numerous or destructive to warrant control. Nougaret, Davidson, and Newcomer [603] list the insect from Oregon (1913), Washington (1914), and New York (1894).[604]

The pear slug, *Eriocampoides limacina* (Retzius), is a European insect first noted by Réaumur [605] in 1740 and described as *Ten-*

[600] Calif. State Dept. Agr., *Spec. pub. 2*, 6 pp. (May 15, 1922).

[601] Marlatt, C. L., *Revision of the Nematinæ of North America*, U. S. Dept. Agr., Tech. Ser. no. 3, pp. 122, 123, fig. 10 (1896). Orig. description.

Essig, E. O., *Injurious and beneficial insects of California*, ed. 2, p. 360, fig. 356 (1915); *Insects of Western North America*, pp. 765–766, figs. 643–644 (1926).

Nougaret, R. L., Davidson, M. W., and Newcomer, E. J., *The pear leaf-worm*, U. S. Dept. Agr., Bul. 438 (Prof. paper), 23 pp., 2 pls., 4 figs. (Dec. 11, 1916).

[602] *A treatise on the insects injurious to fruit and fruit trees of California* (Sacramento, 1881), pp. 20–21, figs. 6–7.

Injurious insects of the orchard, vineyard, etc. (Sacramento, H. S. Crocker & Co., 1883), pp. 120–121, fig. 98.

[603] *Op. cit.*, pp. 1–2 (1916).

[604] The New York records are open to question.

[605] Réaumur, R. A. F. de, *Mémoires pour servir à l'histoire des insectes*, vol. 5, p. 97, pl. 12, figs. 1–6 (1740).

thredo limacina by Retzius [606] in 1783. That it is an important insect may be gathered from the 72 separate citations to literature by Dalla Torre.[607]

FIG. 102.—The larvæ of the bristly rose slug, *Cladius isomerus* Norton, and work on rose leaves. This American insect was first noted in California at Alameda, October 10, 1921. At the present time it is the most serious pest of roses in the San Francisco Bay region.

Although commonly considered a native American species, this insect must have been introduced into New England from Europe at an early date for it was fully described and illustrated by Peck in 1799.[608] Since then it has been generally distributed throughout

[606] Retzius, A. J., *Genera et species insectorum etc.*, p. 73, no. 313 (1783).
[607] Dalla Torre, C. G. de, *Cat. Hymenopterorum*, vol. 1, pp. 195–196 (1894).
[608] Peck, W. D., *Natural history of the slug worm*, Mass. Soc. for Promotion of Agr., pp. 9–20, 1 pl. (1799). Boston.

the pear and cherry districts of North America. Riley[609] reported it from Illinois and neighboring states in 1868.

In California it was recorded as a pest in the Santa Clara Valley in 1875 [610] and again as a serious pest of pear and cherry in the same locality in 1884.[611]

In 1883 Matthew Cooke[612] stated that "the pear slug is found in many orchards in central California."

At this writing the insect is common throughout the state wherever the pear and cherry is commercially grown and is perhaps most abundant in the San Francisco Bay region.

CYNIPIDÆ (Family). Gallflies.

Flea seeds or jumping galls, produced in great numbers on the undersides of the leaves of the valley oak, *Quercus lobata* Nee., were first presented to the California Academy of Sciences by Henry Edwards in 1872 and were pictured and fully described by him in the Pacific Rural Press in 1874.[613] The insect producing the galls was named *Cynips saltatorius* now *Neuroterus saltatorius* (Edwards).

AGAONIDÆ (Family). Fig Wasps.

The blastophaga, *Blastophaga psenes* (Linn.),[614] was first introduced into California in 1891 through the efforts of James Shinn,

Separate, 14 pp., 1 pl. (1799). Boston. A gold medal and $50.00 were awarded for this article.

[609] Riley, C. V., *Prairie Farmer*, n. s., vol. 21, p. 410 (June 27, 1868).

[610] *Pacific Rural Press*, vol. 10, p. 217 (Oct. 2, 1875).

[611] Chapin, S. F., Calif. State Bd. Hort. Commrs., *Bien. Rept.*, p. 20 (1884).

[612] *Inj. Insects of the orchard, vineyard, etc.*, p. 119 (1883).

[613] Vol. 7, p. 97 (Feb. 14, 1874). This illustrates a common practice of those days in which technical descriptions were published in popular farm journals.

[614] Westwood, J. O , *On caprification as practiced upon the figs in the south of Europe and the Levant, with descriptions of the insects employed for that purpose, etc.*, Trans. Entom. Soc., London, vol. 2, pp. 214–224 (1840).

Lelong, B. M., *Fig caprification or the setting of the fruit*, Calif. State Board of Hort., Ann. Rept., 1891, pp. 227–259 (1892). In this article Fig. 4, page 229, labeled male, is the female, while Fig. 5, labeled female is the supposed parasite, *Philotrypesis caricæ* (Linn.), which was accidentally introduced with the blastophaga.

Eisen, Gustav, *Biological studies on figs, caprifigs and caprification*, Calif. Acad. Sci., Proc. (2), vol. 5, pp. 897–1003 (1896). (Complete bibliography.)

Roeding, George C., *Account of work of the blastophaga, or caprifig insect, in fertilizing the Smyrna fig*, Rept. 24th Calif. State Fruit Growers' Conv., pp. 131–137 (1900); 14th Calif. Fruit Growers' Conv., 1891, pp. 440–443 (1892); *ibid.*, Proc. 33d Calif. State Fruit Growers' Conv., pp. 42–48 (1908).

Rixford, G. P., *Results of recent investigations in fig culture and caprification*, Calif. State Hort. Comm., Proc., 41st State Fruit Growers' Conv., pp. 223–233 (1912).

fruit grower at Niles, Alameda County, J. Bliss, a missionary in Smyrna, and Gustav Eisen of San Francisco.[615] The shipment consisting of a dozen caprifigs left Lokia, Smyrna, July 2, 1891, and the females of the blastophaga, which were issuing when they

FIG. 103.—Mature caprifigs cut into halves and ready to be immersed in a fungicide to destroy the rot or endosepsis caused by *Fusarium moniliforme* Sheld. var. *fici* Caldis, and thus prevent the spread of the fungus by the blastophaga when they emerge from the sterilized caprifigs and enter the Smyrna figs. (Photograph by I. J. Condit, April, 1928.)

reached San Francisco, were immediately taken to Niles and liberated in the orchard of James Shinn on July 25, 1891. The figs and container were hung in the tree. According to Howard it did not become established—See Yearbook, 1900, pp. 79–106 (1901).

In 1892, Geo. C. Roeding, pioneer nurseryman and fruitgrower, secured several shipments of figs containing blastophaga from

Condit, I. J., *Bits of fig history in California*, *ibid.*, Mthly. Bul., vol. 8, pp. 260–265, figs. 118–120 (1919).

Caprifigs and caprification, Calif. Agr. Expt. Sta., Bul. 319, pp. 341–375, 23 figs. (1920).

[615] *Insect Life*, vol. 4, pp. 128–129 (1891).

Zoe, vol. 2, pp. 114–115 (1891).

Thomas Hall of Smyrna. However, the insects did not become established. A similar fate befell a second lot received by Roeding from A. C. Denotovitch in 1895.[616] In 1898, W. T. Swingle, of the U. S. Department of Agriculture, sent a lot of caprifigs containing blastophaga [617] from Naples, Italy, but again the insect was not established. A later sending of winter caprifigs by Swingle from Algeria, was received by L. O. Howard in Washington, D. C., on March 31, 1899. Some of these were sent on to Fresno, where they arrived on April 15 and later. From these figs the blastophaga was first successfully established and by December of that year four generations of the insect had been reared.[618] In 1900 E. A. Schwarz was sent to Fresno by Howard to study and report upon the insect.[619] It was found to be most successful and colonies were sent to Niles during that year.

During the years that have followed, many life history studies of the blastophaga have been made by Rixford [620] and Condit.[621]

Just prior to 1927 a great deal of damage to figs had been caused by certain fungous diseases causing internal rot of the fruit. Studies by plant pathologists led them to believe that at least some of these fungi were carried into the figs by the blastophaga. In order to prevent this, a huge state-wide campaign was inaugurated during the winter of 1927–1928 to remove from the capri trees all of the mammæ or over-wintering crop, all of the valuable ones of which were placed in cold storage while the unsuitable ones were destroyed. When the insects were ready to emerge in March, the figs were cut in halves (Fig. 103), dipped for fifteen minutes in a one-half of one percent solution of formaldehyde and then placed in dark incubators to hasten the emergence of the adult blastophagas which were collected in glass tubes fitted to holes in the incubator (Fig. 104). It was believed that the adults, liberated on the caprifig trees would enter the profici crop and pollenate the Smyrna figs. The task was enormous and great expectations of complete success were entertained by the University, State, and

[616] Condit, I. J., *Op. cit.*, p. 264.

[617] Another insect, *Philotrypesis caricæ* (Linn.), a supposed parasite of the blastophaga, was included in this shipment, but ultimately perished with the host. There is some question now as to whether or not this is a parasite of the blastophaga.

[618] Howard, L. O., U. S. Dept. Agr., *Yearbook, 1900*, p. 155 (1901).

[619] Schwarz, E. A., *A season's experience with figs and fig-insects in California*, Proc. Entom. Soc. Wash., vol. 4, pp. 502–507 (1901).

[620] Rixford, G. P., *Results of recent investigations in fig culture and caprification*, Calif. Hort. Com., Mthly. Bul., vol. 1, pp. 623–633 (1912).

[621] *Op. cit.*

County officials in charge of the undertaking. Unfortunately there was not a sufficient number of adults to supply all of the demands from the fig growers and some of the adult blastophaga wasps were too weak to accomplish reproduction when liberated. In all

FIG. 104.—A view in the fig insectary at Fresno, California, showing the glass tubes for collecting the blastophaga as they emerged from the sterilized caprifigs. They were then liberated in the orchards. (Photograph by C. Clower, April, 1928.)

100,000 tubes, each containing about 500 adults of the blastophaga were actually furnished, whereas the demands were for 500,000 tubes.

In some cases fig endosepsis was reduced from 60% to 70% during the 1928 campaign. Although there was much disappointment and enforcement was very unpopular, those in charge believed the campaign thoroughly warranted and that clean blastophaga will insure clean figs. No further state-wide campaigns are planned but different localities and individual growers will no doubt carry on similar experiments during the coming years.[622]

[622] Smith, R. E., and Hansen, H. N., *The improvement of quality in figs*, Calif. Agr. Exp. Sta., Circ. 311, 23 pp., 16 figs. (1927).

EURYTOMIDÆ (Family). Eurytomid Wasps, Jointworms.

Jointworms are reported injuring wheat at San José as early as 1853 and again in 1880,[623] and at Healdsburg in 1879,[624] but there is no way of identifying the species. It is possible that the former may be *Harmolita californica* (Howard), which infests wild grass in the Santa Cruz mountains, or one or more of the many native species may be involved.[625]

FORMICIDÆ (Family). Ants.

The Argentine ant, *Iridomyrmex humilis* Mayr,[626] was first noticed on the Jonathan S. Slauson place at Azusa in 1902 by C. W. Woodworth, but at that time he did not know what it was and paid no further attention to it until it was taken later in 1907 by J. Chester Bradley, probably at Upland. In 1908 it was located at Azusa, where it had been seen in 1902, Los Angeles, Alameda, East Oakland, San Francisco, San José, Cupertino, and near Campbell. Specimens were determined by W. M. Wheeler, who reported it as having been a pest at New Orleans for a number of years. At that time carbon disulfide was suggested as a means of control. At the meeting of the Pacific Coast Entomological Society, held in San Francisco, August 22, 1908, E. M. Ehrhorn called attention to the presence of the Argentine ant in Oakland and stated that specimens had been determined by Theo. Pergande. By 1910 it occupied about 5,000 acres in the state, there being 40 or more known colonies. Eradication was thought possible and was suggested by Woodworth. An ant syrup containing a weak poison was invented by Woodworth in 1910, which has been the basis for all control measures employed against this insect since that time

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Johnstone, H. W., *Was the fig endosepsis campaign a failure?*, Calif. Cult., vol. 71, pp. 680–681 (July 16, 1928).

Hansen, H. N., *Endosepsis and its control in caprifigs*, Phytopath., vol. 18, pp. 931–938, 2 figs. (1928).

Merced will clean caprifigs, Pacific Rural Press, vol. 117, p. 242 (Feb. 23, 1929).

623 *Pacific Rural Press*, vol. 19, p. 72 (Jan. 31, 1880).

624 *Ibid.*, vol. 18, p. 72 (Aug. 2, 1879).

625 Essig, E. O., *Insects of Western North America* (N. Y., Macmillan Co., 1926), pp. 846, 848–849.

626 Woodworth, C. W., *The Argentine ant in California*, Calif. Agr. Expt. Sta., Circ. 38, 11 pp., 2 figs. (Aug., 1908).

The Control of the Argentine ant, *ibid.*, Bul. 207, pp. 53–82, 28 figs. (1910).

Essig, E. O., *Injurious and Beneficial Insects of California*, ed. 2, pp. 379–381, fig. 380 (1915).

Insects of Western North America (N. Y., Macmillan Co., 1926), pp. 864–866, figs. 729–731.

FIG. 105.—A remarkable photograph showing hundreds of dead Argentine ants which succumbed in their nest due to the effects of weak arsenical poison.

(Fig. 105). By 1915 it was known to occur at Alameda, Azusa, Berkeley, Byron Hot Springs, Campbell, Claremont, College Park, Corona, Cupertino, Emeryville, Fruitvale, Los Angeles, Martinez, Melrose, Monrovia, Montecito Canyon, Oakland, Piedmont, Riverside, San Francisco, San José, Santa Clara, San Mateo, Stege, Stockton, and Upland. Since that time practically all of the intervening territories between these various places has been invaded. The ant does not appear to make any headway in the northwest where the winters are excessively wet or in those portions of the state with heavy snows and freezing winters. The mild and temperate portions are apparently most favorable for their development. It is only by constant, vigorous community action that this most serious household pest can be kept reduced to inconsequential numbers. When poisoned weakly, honey, syrups, and sweetened gelatines are used most successfully for control.

APIDÆ (Family). Bees.

The honeybee. The manner of the introduction of the honeybee, *Apis mellifica* Linn., into California, though wrapped in a shroud of mystery to some folks, seems not at all confusing when the facts are at hand. There are those who reason that this useful insect must have been introduced by the Spaniards or Mexicans during the Mission Period, but a careful perusal of the Spanish history of California has failed to reveal any mention of it at all. Palou [627] who gave a detailed account of the happenings leading up to, and including the Spanish settlement of California by the Mission Fathers, gives also an inventory of the livestock, seeds, and agricultural implements which were to be found at five of the important missions during the year 1773. Nowhere does he mention bees or honey.

Of the many travelers also who made observations in California during and immediately following the Mission Period, none makes mention of this insect. One of these, Capt. F. W. Beechey,[628] spent some weeks in San Francisco in November, 1826, and visited, either personally or by proxy, the Missions at San Francisco,

[627] Bolton, H. E., *Palou's New California*, vols. I–IV (1926).

[628] Beechey's ground squirrel, *Citellus beecheyi* Richardson, which bears the name of this explorer, was collected by Dr. Alexander Collie, the surgeon of Beechey's ship, the *Blossom*, in the neighborhood of San Francisco or Monterey in 1826. It was described by Sir John Richardson in 1829 (Fauna Boreali-Americana, Zool., pp. 170–172, 1829).

Santa Clara, San José, San Juan Bautista, and Monterey. That he had some interest in bees may be inferred from a chapter in his travels entitled Mexican Bees,[629] which he discussed even to the species. Certainly he would hardly have overlooked the common honeybee if it occurred at the Missions in California.

It has also been stated that, following the establishment of the Russian settlement of Sitka by Count Alexander Baranof, the priests and monks of the Greek Church brought from their home in Kazan "a double-walled straw keep and its hoard of toilers" and thus established the honeybee on the shores of America. Descendants of these were supposed to have been brought to Fort Ross, California, soon after it was founded in 1812. It is further claimed that evidences of this Russian strain still persists in the bees found in the territory formerly occupied by the Russians.[630] In this connection it is worthy of note that the Russians introduced into California none of the domestic animals used at Fort Ross. Cattle, horses, and sheep were purchased directly from the Spanish. It will also be seen from the American introductions in 1853 that it was with great difficulty that bees were transported from the eastern states via Panama to California. How much more difficult in 1809 to transport these insects from far away Kazan in the middle of Russia via the Baltic or Black Sea and around Cape Horn or the Cape of Good Hope (at least a year's journey) as compared with a month from Philadelphia to San Francisco.

J. F. Eschscholtz, Russian entomologist and naturalist, twice accompanied Otto von Kotzebue to Alaska and California. They were at Sitka in August of 1824 and again during the period from February 23 to August 11, 1825. No mention was made of honeybees in Alaska. Both Eschscholtz and Kotzebue visited Fort Ross in 1824. On this trip Eschscholtz remained there for over a week, and, although an account is made of crops, livestock, and of insects collected there, no mention is made of either bees or honey. I have also read a number of historical accounts of the Russians and their activities at Fort Ross all of which are devoid of the claims made concerning "the hoard of toilers from far away Kazan." In the accounts of the transfer of ownership to John Sutter, bees are not found in the inventory.

[629] Beechey, F. W., *Narrative of a voyage to the Pacific and Beering's Strait in the years 1825–1828* (1831), new ed., 2 vols., vol. 2, pp. 357–365.
[630] Parks, H. B., *American Bee Journal*, vol. 57, pp. 201–202 (1917).

All probabilities of the Russians having introduced honeybees into Alaska and California is set to rest by letters which I have received from Rev. A. P. Kashevaroff, Curator and Librarian of the Library and Museum, Territory of Alaska, Juneau, March 9, and April 30, 1927. Kashevaroff is an authority on the history of the Russians in America and his word is of great importance. He says " . . . in reference to the introduction of bees to Sitka from Kazan in 1801, I regret very much that I am unable to be of assistance to you on this subject. H. W. Alberts of the experimental station at Sitka had acquainted me with your wishes prior to the receipt of your letter. Since getting Dr. Alberts' letter I have searched all available records in our library on this subject, but without success. Historian Tikhmenief, who gives all the activities of the Russian American Company from the very beginning of Alaskan history, does not mention anything on the culture of bees in Alaska. K. Khlébnikof, who goes into the smallest details on the resources of Alaska, the manufactured products, the establishment of Fort Ross, is silent on this subject. Father Veniaminov, who writes so fully on the plants, the fauna, the meteorology and most every object imaginable, does not mention the bees.

"I have come across the following, contained in a letter from A. Baranof addressed to Kuskof at Fort Ross and dated about the year 1813: '. . . .It is also necessary to investigate whether in the peninsula of the lesser Bodega, in the valleys and in the fields, there are not those beneficial insects, i.e., bees, which produce honey and wax essential to the prosperity and social life of mankind.' [631]

"Sitka (or New Archangel) was first established in 1799 and destroyed in 1801. The present Sitka was not established until 1804. For many years after the establishment of the post the first settlers had a very hard time for their very existence and but few ships reached Sitka. The first ships to circumnavigate the world arrived in Sitka in 1804. The time for the voyage was from eight months to a year.

"In 1900 one of our missionaries, Father Methodius, tried bee culture at Sitka but without success. The experimental station at Sitka tried this at the same time but also failed to have any results."

The pioneer beekeeper of California and experienced apiarist in Pennsylvania, J. S. Harbison,[632] gives a clear statement of the introduction of the honeybee into California by the Americans. In a

[631] Potiekhin, V., *Zaselenie Rossa*, Kalifornia (St. Petersburg, 1859).

[632] *Introduction of the Honeybee to California*, American Bee Journal, vol. 59, pp. 268–270 (1919).

letter from F. G. Appleton, apiarist at San José, to Harbison, bearing the date January 11, 1860, it is recorded that "the first bees imported into California were in March, 1853. Mr. (C. C.) Shelton[633] purchased a lot consisting of twelve swarms, of some person to me unknown, at Aspinwall (Panama)." After the continued trip across the Isthmus and thence by water to San Francisco, only one

FIG. 106.—John S. Harbison, a successful Pennsylvania beekeeper and also the pioneer apiculturist of California, at his apiary in Harbison Canyon, amid the wild sages, buckwheats, and sumacs of the El Cajon Valley, San Diego County, California, June 15, 1909. (Photograph taken by his daughter, Mrs. Hinkle, and furnished by Fred Hanson.)

hive of living bees remained. This was taken to San José and gave rise to three swarms the first season. Shelton was killed soon after his arrival by an explosion on the steamer *Jenny Lind* and two hives were sold at auction to James W. Patrick in December, 1853, for one hundred and five dollars and one hundred and ten dollars respectively, to settle the estate. In November, 1855, William Buck arrived with eighteen out of thirty-six swarms which he brought from New York. In 1854 Harbison bought a swarm of bees from Patrick and thus acquired descendants of the first introduction by Shelton, and in the same year he purchased a half

[633] Ewer, W. B., *History of California Agriculture*, Pacific Rural Press, vol. 10, p. 313 (Nov. 13, 1875).
Harbison, J. S. *The bee-keeper's directory* (S. F., Bancroft, 1861), pp. 37–38.

interest in the Buck apiary. Buck again went east and returned in February, 1856, with forty-two colonies of which but seven were saved. In this year the apiary of Buck and Harbison had increased to seventy-three colonies and they sold four hundred pounds of honey for from a dollar and a half to two dollars a pound. In the same year also William Briggs brought one swarm to San José which increased to seven or eight the next summer.

A. P. Smith introduced the first hive of bees into the Sacramento Valley at Sacramento in 1855, but his swarm soon perished. The

FIG. 107.—The first honey house in California was built in Harbison Canyon by John S. Harbison in 1880. Fred Hanson, who furnished this photograph, taken on May 15, 1927, is standing at the door.

next year Harbison had a hive brought directly from the East to his home four miles below Sacramento. In 1857, he returned to his apiary at Newcastle, Lawrence County (Pennsylvania), and prepared sixty-seven colonies for shipment to California. He accompanied these in person and left November 5, 1857, by steamer to Panama, crossed the Isthmus and continued the journey by boat to San Francisco, arriving on the thirtieth of the same month. On opening the hives he found that the bee moth, *Galleria mellonella* Zeller, had been very active in the tropics and had utterly destroyed no less than five colonies. Fifty swarms survived the trip and this splendid showing was due to the untiring efforts of the owner in caring for the bees en route. In 1858 he again went east for more bees and on the return was accompanied by his brother, W. C. Harbison. He left the East with 114 colonies, 46 of which

were from his home county and 68 from Centralia, Illinois. He arrived at Sacramento with 105 living colonies on January 1, 1859. The cost of bringing 110 colonies from Pennsylvania to California, a distance of nearly six thousand miles, was eighteen hundred dollars.[634]

Soon after the last importation he sold 240 colonies at a hundred dollars each.

Bees were introduced into southern California about 1854, according to the accounts of Harris Newmark of Los Angeles who states, "Somewhere I have seen it stated that in 1854, O. W. Childs brought the first hive of bees from San Francisco at a cost of one hundred and fifty dollars;[635] but as nearly as I can recollect, a man named Logan owned the first beehives and was, therefore, the pioneer honey producer. I remember paying him three dollars for a three pound box of comb-honey, but I have forgotten the date of the transaction. In 1860 Cyrus Burdick purchased several swarms of bees and had no difficulty in selling honey at a dollar a pound. By the fall of 1861 the bee industry had so expanded that Perry and Woodworth, as I have stated (p. 81), devoted part of their time to the making of beehives. J. E. Pleasants of Santiago Cañon, known also for his Cashmere goats, was another pioneer bee-man and received a gold medal for his exhibit at the New Orleans Exposition."[636]

Harry S. Merriam,[637] an old time beekeeper and resident of Twin Oaks Valley since 1876 recently delivered an address before the Vista Women's Club and their husbands, and in part said:

"During the first years, before the settlers were able to grow their crops to maturity and market them—because of persecution by the vaqueros of the Spanish grants—they were able to carry on by keeping bees. The honey industry at that time was considerably greater than at present. In years of plentiful rainfall, the hills and valleys were perfect gardens of wild flowers, but in those days the valley was carpeted with bloom, and it was a wonderful place for bees. The honey was shipped to Australia in 25 gallon pine barrels, coated inside with a paraffine-like preparation. W. W. Stewart was one of the principal handlers of the honey, who with Charley Hamilton, who is still in business, were the biggest shippers."

[634] Pleasants, J. E., *Sixty years of beekeeping in California*, American Bee Journal, vol. 61, pp. 7–9 (1921) (Portrait of Harbison).

[635] Probably included cost of the swarm.

[636] Newmark, Harris, *Sixty years in Southern California* (N. Y., Knickerbocker Press, 1916), p. 127.

[637] Fred Hanson, *Bees and honey*, vol. 8, p. 162 (1927).

During the winter from October 1, 1858, to April 1, 1859, over a thousand colonies were shipped from New York to California, but due to a lack of knowledge of preparation and shipment, not more than two hundred survived the trip.

A Mr. Gridley brought four colonies from Michigan across the plains in a wagon. By stopping at intervals along the way to allow the bees to feed he arrived at Sacramento safely with them on August 3, 1859. During the winter of 1859–1860 approximately six thousand hives were imported into the state. As many of these colonies were infested with foul brood, about half were destroyed en route.

In 1858 F. G. Appleton at San José had 125 hives.[638]

Harbison moved from Sacramento to the El Cajon Valley, San Diego County, in 1864 [639] and entered into partnership with R. G. Clark. Here his apiary increased rapidly and he had at one time as many as 3,750 colonies in twelve different apiaries (Fig. 106). In 1873 he shipped his first carload of section honey [640] to Chicago, where it sold for twenty-seven cents a pound. In one year he shipped ten carloads of honey to New York.[641] Harbison died in 1912.

From the above it will be seen that the bee moth came into the state in 1857 and foul brood in 1858–1859. The statement of Cronise [642] that foul brood was introduced from the Mohawk Valley, New York, in 1868 is probably true, but the disease had already been in the state ten years.

In 1871 W. Muth-Rasmussen brought to California the first honey extractor and in 1872 John Beckley used the first Langstroth hive. In 1875 the production of honey in California was 1000

[638] Calif. State Agr. Soc., *Trans. for 1858*, pp. 235, 254 (1859).

[639] G. H. Vansell tells me that Harbison's chief reason for moving from Sacramento to San Diego was to escape buckeye poisoning. See *Buckeye poisoning of the honeybee*, by G. H. Vansell, University of California Agricultural Experiment Station, Circular 301, 12 pp. (1926).

[640] Harbison invented a hive using two-pound sections in 1857–1858, before the Langstroth hive came into use.

[641] Pellett, F. C., *A California Pioneer: the interesting career of J. S. Harbison, the first commercial honey producer on the Pacific Coast*, Am. Bee Jour., vol. 59, pp. 122–123 (1919). A correspondent to the *Pacific Rural Press* in 1876 states that Harbison moved to San Diego in the fall of 1869 and that he shipped eight carloads of honey one year to Chicago. *Pacific Rural Press*, vol. 11, p. 339 (May 27, 1876).

[642] Cronise, T. F., *The Natural Wealth of California* (San Francisco, 1868), pp. 372–373.

tons.[643] A moth-trap hive was in use in 1877. With the great impetus to planting eucalyptus throughout the state in 1877 [644] came the fear of poisoning the bees, but this was dispelled the following year.

During the past fifty years beekeeping has maintained itself as a very important pursuit in California and has brought our state to the foremost in the United States in the production of honey.

A bill providing for the control of foul brood was introduced into the state legislature in 1883 but did not pass. The state bee law, which provided for the control of foul brood and other diseases and for the appointment of county bee inspectors, was passed in 1901, and was not materially changed until 1927, although many attempts were made to secure the passage of a new act. The new law passed in 1927 may be summarized as follows:

> An act to promote the agricultural interests of California by providing for the inspection and disposition of bees, their brood, hives and appliances that are or may be infected with disease, vesting the enforcement hereof in the state director of agriculture and the county horticultural commissioners and defining their powers and duties hereunder, providing for the establishment of quarantines to prevent the introduction and spread of disease, declaring box hives and appliances to be a public nuisance and providing for the abatement thereof, providing for the registration of apiaries, prohibiting the sale or removal of infected bees, their brood, hives and appliances without permit, providing penalties for the violation hereof, making an appropriation to carry out the provisions hereof, and repealing an act entitled "An act to promote the apicultural interests of the State of California by providing county inspectors of apiaries, and defining their duties, and providing for their compensation, and repealing the act entitled 'An act to authorize the boards of supervisors of the several counties of this state to appoint inspectors of apiaries, and provide for their compensation, and defining their duties, and for the further protection of bee culture,' approved March 13, 1883," approved February 20, 1901, as amended.

In 1926 there were bee inspectors in the following thirty counties of California: Alameda, Butte, Contra Costa, Colusa, Fresno, Glenn, Imperial, Inyo, Kern, Kings, Lassen, Los Angeles, Madera, Merced, Monterey, Napa, Orange, Riverside, Sacramento, San Bernardino, San Diego, San Joaquin, Shasta, Siskiyou, Solano, Stanislaus, Tehama, Tulare, Ventura, and Yolo.

After the passage of the new law in 1927 a program was outlined

[643] Ewer, W. B., Hist. of Calif. Agr., *Pacific Rural Press*, vol. 10, p. 313 (Nov. 13, 1875).

[644] The Eucalyptus was introduced into California in 1850.

by Frank E. Todd, in charge of apiary work in the State Department of Agriculture, calling for (1) registration of all beekeepers in all counties; (2) inspection of apiaries and issuance of reliable certificates, to facilitate the movement of hives and honey; (3) a clean-up and eradication campaign against foul brood. By December, 1927, twenty-seven applicants had been qualified and twenty-three appointed as bee inspectors in the state.

George Vansell, apiarist of the University of California at the northern branch, Davis, has kindly furnished the following estimates for the bee products for California during the year 1925.

Queens and bees produced for market by 25 breeders........	$150,000
Honey production about 20,000,000 pounds, average price from 7¾¢ to 8¢ a pound	
Total value of honey at 8¢................................	$1,600,000
Beeswax (no figures available)	
Total value from sale of queens, bees and honey............	$1,750,000

The honey crop in California ranges from 7,000,000 to 20,000,000 pounds annually, or from 10 to 15 per cent of the total United States production. Southern California produces from 4,000,000 to 15,000,000 pounds yearly, or roughly two-thirds of the total California crop. The year 1926 was an unusually good one in the industry, when the production of extracted honey in the state as a whole probably amounted to 19,691,000 pounds, the largest yield for any year in which accurate data are available. The ten southernmost counties of California produced 74 per cent of the crop in 1926. The 1927 crop of extracted honey in the state as a whole is estimated at 8,703,000 pounds, of which amount southern California produced 5,310,600 pounds, or 61 per cent.[645]

[645] Calif. Cultivator, vol. 70, p. 400 (Apr. 7, 1928), *A review of the beekeeping industry in southern California*, by Security Trust and Savings Bank of Los Angeles (1928).

CHAPTER VI

THE BIOLOGICAL CONTROL OF INSECT PESTS[1]

The biological or natural control of insect pests, whereby certain predacious and parasitic insects are employed to destroy other injurious species, was first put upon a commercial basis in Cal-

[1] Howard, L. O., *A study in insect parasitism*, U. S. Dept. Agr. Div. Entom., Tech. Ser., 5, 57 pp., 24 figs. (1897).

The practical use of insect enemies of injurious insects, U. S. Dept. Agr., Yearbook, 1916, pp. 273–288 (1917) (also issued separately).

Insect parasites of insects, Proc. Entom. Soc. Wash., vol. 26, pp. 27–46 (1924).

Ehrhorn, E. M., *Present status of parasitism*, Calif. State Hort. Com., Proc. 33d Calif. State Fruit Growers' Conv., pp. 147–159 (1908).

Pease, S. A., *Parasites and the state insectary*, *ibid.*, 34th Conv., pp. 39–49 (1908).

Cook, A. J., *Parasitic control of injurious insects*, *ibid.*, pp. 49–55 (1908).

Fiske, W. F., *Parasites of the gypsy and brown-tail moths introduced into Massachusetts.* Where they come from—What they are doing—A general survey of the work. (Wright & Potter, Boston, 1910), 56 pp., 22 figs., 3 diagrams.

Howard, L. O., and Fiske, W. F., *The importation into the U. S. of parasites of the gipsy moth and brown-tail moth*, U. S. Dept. Agr., Bur. Entom., Bul. 91, 334 pp., 74 figs., 21 pls. (3 col.), 2 maps (1911).

Smith, H. S., *The chalcidoid genus* Perilampus *and its relation to the problem of parasite introduction*, U. S. Dept. Agr., Bur. Entom., Tech. ser. 19, pt. 4, pp. 33–69, figs. 24–31 (1912).

On some phases of insect control by the biological method, Jour. Econ. Entom., vol. 12, pp. 288–292 (1919).

The present status of biological control work in California, *ibid.*, vol. 19, pp. 294–302 (1926).

Smith, H. S., and Armitage, H. M., *Biological control of mealybugs in California*, Calif. State Dept. Agr., Mthly. Bul., vol. 9, pp. 104–158, figs. 39–67, 1 col. pl. (1920).

Smith, H. S., and Compere, H., *A preliminary report on the insect parasites of the black scale*, Saissetia oleæ (*Bernard*), U. C. Pub. in Entom., vol. 4, no. 9, pp. 231–334, 63 figs. (1928).

Compere, H., *Report on the biological control work directed against black scale*, Calif. State Dept. Agr., Mthly. Bul., vol. 9, pp. 451–458, fig. 122 (1920).

Armitage, H. M., *Biological control of insect pests of citrus*, *ibid.*, vol. 10, pp. 585–597, figs. 85–91 (1921).

Biological control, with particular reference to the mealybug and black scale work in southern California, *ibid.*, vol. 11, pp. 45–50 (1922).

Biological control of insect pests at the southern laboratory, *ibid.*, vol. 11, pp. 826–836 (1922).

Tothill, J. D., *The natural control of the fall webworm*, Hyphantria cunea *Drury*, *in Canada*, Dom. Can. Dept. Agr., Bul. 3, n. s., 107 pp., 99 figs., 6 pls. (1922).

Metcalf, M. M., *Parasites and the aid they give in problems of taxonomy, geographical distribution, and paleogeography*, Smithsonian Miscl. Coll., vol. 81, no. 8, 36 pp. (Feb. 28, 1929).

Also see bibliographies under Beneficial Insects Introduced into California.

The author is indebted to H. S. Smith for reading and making many corrections and additions to this paper.

ifornia.[2] It seems impossible to determine the exact origin of the idea, for since the earliest times, these beneficial insects have been observed by scientists and agriculturists. In a report [3] to the Board of State Horticultural Commissioners of California, dated at Nevada City, September 12, 1881, Felix Gillet, commissioner for the Eldorado District, advocated the finding of suitable predacious and parasitic insects and to rear the same as a means of combating the insect pests already established in the state and made this definite suggestion: "The establishing by the State, and under the supervision of the State Horticultural and Viticultural Commissions and Entomologist, of 'stations' where to raise and learn how to raise predacious insects of the kinds that prey upon the noxious insects that are making such ravages in our orchards, vineyards, and fields." [4] It is also stated that public attention was first called to the idea by Alexander Craw of Los Angeles.[5]

C. V. Riley first took notice of the cottony cushion scale in California in 1872 and at once endeavored to locate its native country and its economic status therein.

Through D. W. Coquillett and Albert Kœbele he also accumulated a vast amount of data relating to the insect in southern California. Among other things the natural enemies were studied. In 1886 [6] the predators listed, consisted of a *Chrysopa* sp., *Hippodamia convergens* Guer. (form *ambigua* Lec.) and the larva of the introduced moth, *Holcocera iceryæella* (Riley) (*Blastobasis*), from Australia, which has since become a pest of oranges, and the single parasite, *Isodromus iceryæ* Howard, which has proven to be parasitic on *Chrysopa* and *Sympherobius*. In 1883 [7] the list included twelve predators and six parasites in California. These examples are sufficient to indicate that there was a real interest already aroused in this particular phase of the Icerya problem. In 1887 Riley visited California and made a personal investigation of the situation and expressed to the fruit growers of the state [8] his regret

[2] This method of insect pest control has also reached a high state of perfection at the present time in the Hawaiian Islands and other parts of the United States.
[3] Bd. State Hort. Commrs., Calif., *First Rept.*, pp. 27–28 (1882).
[4] *Loc. cit.*, p. 28 (1882).
[5] Calif. State Bd. Hort., *Rept.*, *1889.* p. 260 (1890).
[6] U. S. Dept. Agr., *Rept. 1886*, pp. 484–486, pl. 3 (1887); *ibid.*, *Bul. 15*, p. 13 (1887); *Pacific Rural Press*, vol. 33, p. 361 (Apr. 16, 1887).
[7] *Insect Life*, vol. 1, p. 130 (1888); *Pacific Rural Press*, vol. 34, p. 49 (July 16, 1889).
[8] *Pacific Rural Press*, vol. 33, pp. 361–362, 364 (April 16, 1887); U. S. Dept. Agr., Div. Entom., *Bul. 15*, pp. 9–26 (1887).

that there were no funds available to send agents to Australia to study, collect and send beneficial insects into California. But he sought additional information through correspondence from W. M. Maskell and L. M. Kirk, of Wellington, New Zealand; F. S. Crawford, Adelaide, and E. J. Dunn and Baron Ferdinand von Müller, Melbourne, Australia; and Roland Trimen, Cape Town, South Africa.

In the meantime in order to hurry matters a resolution was passed by the California State Board of Horticulture at a meeting held at Riverside, April 12, 1887,[9] asking "that a memorial to Congress be prepared, setting forth the needs of this coast in the matter of exterminating insect pests, and asking that an adequate appropriation be made to be used by the Division of Entomology in the Agricultural Department of the United States, in the investigation of the parasites and predacious insects of the cottony cushion scale, and all other injurious scale insects in their native country, Australia, and their introduction into this country."

Following this action, "Hon. C. N. Felton, of San Mateo, introduced a resolution authorizing the Commissioner of Agriculture to at once delegate an agent to visit Australia, New Zealand, and other countries, in search of parasites, if any were found preying on scale insects there." This resolution failed in Congress, but the California Board of Horticulture was persistent and at a meeting held at Santa Rosa, November 11, 1887, adopted another similar resolution, which was formulated into a petition and forwarded to Congress "together with a statement of the ravages committed by scale insects in our state." A third resolution was passed at the Santa Barbara meeting, April 10, 1888, petitioning Congress for an appropriation of not less than $50,000 to be used for the introduction of beneficial insects. All of these resolutions failed to move Congress and no support came from that source.

However, as a result of Riley's correspondence with Australia, Crawford sent to California two small lots of a dipterous parasite. The first of these, packed in a small tin box, was mailed to W. G. Klee, who received them about the middle of April, 1888, and who turned them over to Albert Kœbele of Alameda for propagation and liberation.[10] The second lot, consisting of a few parasitized scales, was received by D. W. Coquillett at Los Angeles in late April of the same year.[11] Adults of this parasite were described as *Lestophonus iceryæ* by Williston [12] in July, 1888. Now it happened that Congress had appropriated a large sum of money to provide for an exhibit at the Exposition at Melbourne in 1888 and through

[9] Calif. State Bd. Hort., *Rept., 1889*, p. 260 (1890).

[10] *Pacific Rural Press*, vol. 35, p. 245 (Apr. 21, 1888).

[11] *Ibid.*, vol. 35, p. 378 (Apr. 28, 1888).

[12] Williston, S. W., *An Australian parasite of* Icerya purchasi, Insect Life, vol. 1, pp. 21–22, 1 fig. (July, 1888).

the efforts of the Hon. J. De Barth Shorb of San Gabriel, California, G. L. Rives, Assistant Secretary of State, and N. J. Colman, Commissioner of Agriculture, and C. V. Riley, the Chief of the Commission in charge of the exhibit, Hon. Frank McCoppin of San Francisco, consented "to set aside a sufficient sum to defray the expenses of two agents," [13] who though ostensibly sent to represent the Department of State, were in reality to devote their time to study, collection and sending to California, of parasites and predators of the cottony cushion scale.

Alexander Craw had already advocated sending Coquillett for this purpose and Riley also considered him for the mission, but he finally decided to send Kœbele, preferring to keep Coquillett in southern California to propagate and distribute the parasites upon their arrival there. Accordingly Kœbele sailed from San Francisco for Australia on August 25,[14] 1888. He was particularly instructed to secure the dipterous parasite and as many other natural enemies as possible.[15] Upon his arrival in Australia he began to collect parasitized scales for shipment to California. The first lot (see cottony cushion scale, p. 123) was received by Coquillett in December, 1888. The material was placed in a small tent (Fig. 119), constructed over an orange tree, infested with the cottony cushion scale. This formed the first successful introduction of this parasite into the southern part of the state.

In order to justify the expenses of Kœbele's mission from the standpoint of the Department of State, F. M. Webster was sent to Australia on December 15, 1888, "but remained there only one month and had little opportunity for entomological research, as he was charged with assisting in the preparation of a report for the State Department on the agricultural aspects of the Melbourne Exposition."

Just prior to leaving Australia in February, 1889, Kœbele sent another lot of the dipterous parasite and a large number of four different species of ladybird beetles, all of which arrived safely in southern California and were cared for by Coquillett.

In his investigations of *Cryptochætum* in Australia Kœbele

[13] Calif. State Bd. Hort., *Rept.*, *1889*, pp. 261–262 (1890).

[14] In the California State Bd. Hort., *Rept. 1889*, p. 262 (1890), the date is given as August 20th.

[15] *Insect Life*, vol. 1, pp. 64–65 (Sept., 1888).

Report of a trip to Australia to investigate the natural enemies of the fluted scale by Albert Kœbele, U. S. Dept. Agr., Div. Entom., *Bul. 21*, 32 pp., 16 figs. (1890).

discovered a chalcidoid parasite on the pupæ of the beneficial fly and immediately warned Riley and Coquillett [16] regarding it. In January, 1889, Coquillett discovered this secondary parasite, but successfully prevented its escape from the breeding cages.[17] This circumstance often met with in the introduction of beneficial insects from foreign countries, shows the importance of intrusting the same only to thoroughly trained men who understand all of the complex phases of the problems involved.

Although the vedalia (Fig. 108) was described from Australia as early as 1850, Kœbele appears to have first noted it feeding on the cottony cushion scale in that country in 1888 and began sending it to California at once. The first lot of the vedalia, *Rodolia cardinalis* (Mulsant) (*Vedalia, Novius*), consisting of 28 adult specimens, were received by Coquillett on November 23, 1888. They were reared in tents similar to the one used for the dipterous parasite (Fig. 119). The second lot consisting of 44 adults arrived in southern California December 29, 1888, and the third lot on January 24, 1889. In all there were received from the three sendings a total of 129 adult specimens.[18] Two other shipments followed: one on February 21, 1889, consisting of 35 adults and the last on March 20, 1889, numbering 350 specimens. These last two lots were colonized directly in the infested orchards. From the first three lots, propagated artificially in tents by Coquillett, 10,555 adults were distributed to the orchardists by June 12, 1889. The first beetles were colonized from the cages upon the trees in the orange orchard of J. W. Wolfskill at Los Angeles; the two colonies liberated directly in the orchards were in those of A. S. Chapman in the San Gabriel Valley. Other colonies from the cages were placed in the orchards of J. R. Dobbins, San Gabriel, and sent to various parties in the counties of Los Angeles, San Mateo, Santa Clara, Alameda, Santa Cruz, Sonoma, Napa, Marin, Eldorado, San Joaquin, and Tulare. In all cases great success was soon reported.[19] The results obtained were far ahead of the best expectations, being no less than phenomenal. It is related that "orchards that had been rendered comparatively worthless through the ravages of the cottony cushion scale were restored to their former condition, and today we can make known to the world that our

[16] *Insect Life*, vol. 1, p. 232 (Feb., 1889).
[17] *Ibid.*, vol. 1, p. 262 (Mar., 1889).
[18] *Insect Life*, vol. 2, pp. 73–74 (1889).
[19] *Ibid.*, pp. 267–269 (1890).

orchards are again practically free from the ravages of this dreadful pest. Orchardists who had given up all hopes of saving their orchards are now jubilant over this 'God-send,' and are now preparing to plant more trees. The *cottony cushion scale is no longer a pest in California*."[20] The vedalia had all the qualifications necessary to succeed, viz.: adaptability, prolificness, a ravenous appetite, and rapid development, and within a year all fear of the dreaded cottony cushion scale was banished and by 1892 the citrus orchards were practically clean as a result. This was a great victory for all parties concerned, the State Board of Horticulture, Albert Kœbele, D. W. Coquillett, and C. V. Riley, and has ever been *the* outstanding example of successful biological control. Kœbele and Webster left Australia in February, 1889, and after a stay in New Zealand, returned to California late in March of that year.

The California State Board of Horticulture believed that other parasites and predators could be introduced to control many of the California insect pests and at the meeting held at National City, April 19, 1889, San Francisco, June 29, 1889, and at Fresno, November 8, 1889, the advisability of sending an agent to Australia to collect parasites was discussed and resolutions and memorials sent to Congress asking an appropriation for this purpose.[21] An attempt was made by the Secretary of Agriculture during the winter of 1888–1889 to use a part of his appropriations from Congress to defray the expenses of a foreign collector but at this time he was unsuccessful.

In 1891 the State Board of Horticulture succeeded in procuring from the State Legislature an amendment to the law creating the State Board of Horticulture in 1883, in an act, Chapter 194, approved March 31, 1891, "appropriating a sum of five thousand dollars for the purpose of sending an expert to Australia, New Zealand and adjacent countries, to collect and import into California, parasites and predacious insects for distribution." With this amount available the Board then applied to the Secretary of Agriculture at Washington to delegate Albert Kœbele on this mission stating that the Board would assume his traveling expenses and requested the Department of Agriculture to pay his salary. This was agreed in May, 1891, and on August 11th Kœbele sailed

[20] Calif. State Bd. Hort., *Rept., 1889*, p. 263 (1890).
[21] *Ibid.*, pp. 263–265 (1890).

from San Francisco on the steamer *Alameda* for Australia.[22] During this trip he spent ten days in Hawaii, four weeks in New Zealand, seven months in Australia, chiefly in New South Wales, and two months in a visit to New Caledonia and Fiji. He returned from this trip on August 5, 1892. (See list of insects introduced as a result of his trips, pp. 367–371.)

The results of Kœbele's work gave a great impetus to biological control and Ellwood Cooper, chairman of the State Board of Horticulture, became an enthusiastic advocate of this method of dealing with the many serious pests already evident in the orchards and fields of the state.

As a result of Cooper's efforts George Compere was employed as a foreign collector and sent to Australia and adjacent countries in 1899 to seek other desirable natural enemies, particularly for red, purple, and black scales. He scouted throughout parts of Australia, Java, India, China, the Philippine Islands, Japan and neighboring regions until 1901 when he resigned to accept a similar position with the state of Western Australia. In 1904 he again entered the services of California jointly with Western Australia and visited many parts of the Mediterranean Region, Southern Asia, South Pacific Islands, and Brazil. He sent a vast amount of material to California including a number of promising ladybird beetles among which were, *Stethorus vagans* (Blackb.), from Australia in 1901 and *Scymnus bipunctatus* Kugel., from the Philippine Islands in 1910 and the codling moth parasite, *Calliephialtes messor* (Grav.), from Spain in 1904–1905. He also informed the California State Horticultural Commission regarding the seriousness of the many different kinds of fruit and vegetable flies of the family Trypetidæ, and the necessity of strict quarantine on the same.

Cooper's ideas of biological work at this time are well expressed in the following words:[23]

"California is to be congratulated upon the fact that she is the pioneer in the work of fighting insect pests with their natural enemies. For years we have stood alone in this work, but our example is now being followed by very many states and territories and by foreign nations, and this state is looked to as the great exemplar in this work. It is true that the good work done by predacious and parasitic insects has been known for a great many years, but

[22] *Ibid., Rept., 1891*, p. 209 (1892).

[23] Cooper, Ellwood, Calif. State Hort. Com., *Second Bien. Rept.*, 1905–1906, p. 18 (1907). The new state insectary in Capitol Park, Sacramento, was completed in 1907.

it remained for California to give a practical turn to this work, and introduce beneficial insects for work upon the destructive species."

In a paper entitled Present Status of Parasitism,[24] E. M. Ehrhorn, chief quarantine officer at San Francisco remarked: "We can hardly expect that all imported parasites will take hold in our State, and if we succeed in getting one good parasite out of every ten, it will pay us to keep up the search. I understand that the cost of going after the *Vedalia* amounts to about $1,500, and if we consider for a moment the enormous value of the citrus industry and what this and the deciduous fruit industry have done to build up California, I think you will agree with me that if we had spent $150,000 we would yet be much ahead of the game. Since the advent of the *Vedalia* in 1888, this State has spent about $50,000 in the search for parasites of our various pests. In my estimation it is a very paltry sum for the industry which we represent; but as long as the farmer and fruit-grower, who really are the interested parties, will not take hold of these vital questions, we shall have to continue our search in a small way."

Compere continued as foreign collector until 1910 when he terminated his services with Western Australia and returned to California to enter the employ of the state in the quarantine service.

No further attempts at biological control were made until after A. J. Cook became State Horticultural Commissioner in 1911. He reorganized the State Insectary in 1912 and appointed H. S. Smith as superintendent in 1913. However, during this interim (1908–1914), E. K. Carnes and E. J. Branigan collected great quantities of the native convergent ladybird beetle, *Hippodamia convergens* Guer., which were sent to the canteloupe growers of the Imperial Valley, and also considerable numbers of the native brown apricot scale parasite, *Encyrtus californicus* Girault (*Comys fusca* How.), which were distributed in small colonies throughout the state.

H. S. Smith, superintendent of the State Insectary, made a trip to Japan and the Philippine Islands in 1913 for the purpose of investigating the possibilities of introducing parasites particularly of the mealybugs, black scale and other scale pests in California. He sent back to California a parasite of the black scale and made arrangements with S. I. Kuwana, Japanese entomologist, to send mealybug parasites.[25] He also collected the ladybird beetle, *Scymnus bipunctatus* Kugel., in the Philippines and brought it to California with him.

[24] Calif. State Hort. Com., *Proc. 33d Fruit Growers' Conv.*, pp. 147–159 (1908).
[25] Calif. Hort. Com., *Mthly. Bul.*, vol. 2, pp. 660–661 (1913); vol. 3, pp. 26–29 (1914).

H. L. Viereck was employed as a foreign collector in southern Europe. Soon after his arrival at Palermo, Sicily, in June, 1914, he began making collections of the egg masses and various stages of the citrus mealybug, *Pseudococcus citri* Risso, and forwarding them to H. S. Smith at Sacramento. As a result of his sendings of this material, the new and effective parasite, *Leptomastidea abnormis* (Girault), of the citrus mealybug was discovered by Smith, who reared and successfully established it. This insect was sent to California during July and August, 1914, and proved so successful that it was reared in quantities and distributed throughout southern California the same year. This proved to be an important introduction and at once gave a new impetus to biological control in California. Viereck returned the last of the year and made no further collections for the state.

During 1916–1917 C. P. Clausen, assistant superintendent of the State Insectary, was sent out as a foreign collector and visited the Philippine Islands, China, Japan, and Formosa. Apparently no important parasites or predators were established in California as a result of this trip, but later on in 1922–1923, when employed by the Bureau of Entomology, he collected a number of interesting insects which were sent to the state insectary for propagation. Among these might be mentioned *Comperiella bifasciata* How., later proved to be a parasite of the red scale (1922), *Coccophagus japonicus* Compere, a parasite of the citricola scale sent over in June, 1922, *Coccophagus yoshidæ* Nakayama also on the citricola scale (1923), *Anicetus annulatus* Timb. on the tesselated scale (1923) and the ladybird beetles, *Chilocorus similis* Rossi, a predator on many of the armored scales (1922), *Hyperaspis japonica* Crotch, a predator on the wax scales (1923) and several mealybug parasites which could not be reared on *Pseudococcus citri* (Risso).

The great losses to the sugar beet industry in California and the difficulty of artificial control led the beet sugar manufacturers to appeal for experiments in the biological control of the beet leafhopper, *Eutettix tenellus* (Baker), and a fund subscribed by them enabled E. J. Vosler, formerly assistant superintendent of the State Insectary, to make two trips to Australia to seek possible parasites of the beet leafhopper. The first trip was made in 1917 and the second trip in 1918. While he did not succeed in his original mission, he introduced into California *Metaphycus lounsburyi* (How.), the very effective parasite of the black scale. The work of

this remarkable parasite in California was so phenomenal that it caused a great revival in biological control. During the years 1920–1922 it looked as if it would completely check and furnish a commercial control for the black scale in the coastal citrus region of southern California. Then the secondary parasite, *Quaylea whittieri* (Gir.), and several other hyperparasites, almost entirely nullified its efficiency and the black scale was practically restored to its former status.

E. W. Rust was appointed foreign collector for the State Insectary in 1923 and continued as such until 1928. He spent most of this time in South Africa, collecting and forwarding to California parasites of the black scale. He returned several times to California bringing certain species along with him. These trips also gave him an opportunity to collect in Australia, various of the South Sea islands and Hawaii. Some of these parasites and predators are very promising, notably *Coccophagus modestus* Silvestri and *Scymnus binævatus* Muls. (See more detailed account of his work and insects introduced by him, under Foreign Collectors.)

F. Silvestri collected certain coccid parasites in China and Japan for the Citrus Experiment Station in 1924 and 1925.

The search for parasites for the beet leafhopper was renewed in October, 1926, when Charles F. Henderson was sent out by the Bureau of Entomology and the University of California to determine the existence of the beet leafhopper in Argentine Republic and secure parasites there if possible. He spent the time from November 10, 1926, until June 30, 1927, exploring that country and did not find the leafhopper in question. However, he did find a closely related species belonging to the same genus which produced a curly top disease of sugar beets there. No parasites were obtained. In October, 1927, Henderson set out to explore the central part and west coast of Mexico and Lower California where he made a careful study of conditions during the period from October 3, 1927, to July 16, 1928. He afterwards extended his explorations into Arizona, Utah, and Idaho from July 22 to September 6, 1928. He found a number of egg parasites of the beet leafhopper and as all of them occurred in California no introductions were made.

Harold Compere, son of George Compere, and assistant in Entomology in the Citrus Experiment Station, made a special trip to Australia in 1927–1928, for the purpose of locating the original habitat of the citrophilus mealybug, *Pseudococcus gahani*

Green, and to find, if possible, its natural enemies. He succeeded in both and returned with six of the latter.

At this time (1929) there is no one actively employed as a foreign collector for the State of California, but no doubt this important phase of biological control will be continued every bit as strenuously in the future as it has in the past.

Certainly the past history of biological control in California has been sufficiently successful to warrant a continued program in the future. With what appears to be a development of strains of pests which are becoming resistant to the ordinary method of spraying and fumigation, the use of natural enemies seems even more important in the future than in the past.

Beneficial Insects Introduced into California [26]

Predacious Insects

NEUROPTERA (Order)

Lacewings

CHRYSOPIDÆ (Family). Green Lacewings.

A large green lacewing, *Chrysopa* sp., probably *Chrysopa ramburi* (Schiner),[27] was noted in New South Wales, Australia, by Kœbele who forwarded specimens to California in 1889. These were liberated in southern California and specimens are reported recovered at the Wolfskill orchard in Los Angeles in April, 1889. [28] As this insect has never been seen since, it is naturally supposed that it never became really established in California.

Harold Compere brought a colony from Sydney to California in March, 1928, and is at present propagating the insect in the insectary at Riverside. A number of liberations were also made in the orchards.

COLEOPTERA (Order)

Beetles

CARABIDÆ (Family). Predacious Ground Beetles.

Pristonychus complanatus Dejean [29] is a European and North American species which was distributed along the California coast

[26] I am indebted to H. S. Smith and P. H. Timberlake for reading and making a number of additions and corrections to this portion of the original manuscript.

[27] See Froggatt, W. W., *Australian Insects* (Sydney, Wm. Brooks & Co., 1907), pp. 65–66.

[28] Kœbele, A., U. S. Dept. Agr., Div. Entom., *Bul. 21*, pp. 13, 14, 32 (1890).

[29] Dejean, P. F. M. A., *Spécies général des Coléoptères de la collection de M. le comte Dejean* (Paris, 1828), vol. 3, p. 58.

as far north as San Francisco Bay by the early Spanish vessels, whalers, and hide ships, prior to the American occupation.

Carabus nemoralis Müller [30] is a European species accidentally transferred to California with plants. It was first collected in Golden Gate Park, San Francisco, by Van Dyke in 1919.[31] In June, 1926, it had reached Portland, Oregon, and a few years later, 1928, it was collected at Seattle, Washington. On August 24, 1928, I received specimens collected in a garden at Eureka, Calif., by Earl Mills.

Calosoma sycophanta (Linn.) [32] was known to Réaumur in France as early as 1736, but was not described by Linnæus until 1758. It was early found to be a valuable predacious beetle in Europe and in 1835 Audouin [33] and Brullé gave an account of the larvæ feeding upon the caterpillars of the gypsy moth in France. After the outbreaks of the gypsy moth and brown-tail moth in Massachusetts, the Bureau of Entomology, U. S. Dept. of Agriculture and the State of Massachusetts arranged to introduce the natural enemies of these pests from Europe and L. O. Howard visited several countries in 1905 to arrange for the collection and transportation of the beneficial insects. Between July 15 and August 1, 1905, the first lot of *Calosoma sycophanta* were received from G. Leonardi, Portici, Italy, which had been collected in Sardinia. Shipments followed during the years 1905 and 1910, which resulted in the introduction of 4,046 adults of this carabid. Of these 67% were liberated in the field and the balance used for propagation and experimental work. As a result the beetle became thoroughly

[30] Müller, O. F., *Zoölogicæ Danicæ prodromus, etc.*, Hafniæ, p. 75 (1776).
Van Dyke, E. C., *Pan-Pac. Entom.*, vol. 1, p. 78 (1924).

[31] It was introduced into Cambridge, Mass., and Nova Scotia, before 1900 and into New York some years later.

[32] Réaumur, R. A. F. de, *Mém. pour servir à l'histoire des insectes*, vol. 2, p. 45, pl. 37, figs. 14–19 (1736).
Linnæus, C., *Syst. Nat.*, ed. 10, p. 414 (1758) (*Carabus*).
Howard, L. O., and Fiske, W. F., *The importation into the United States of the parasites of the gipsy moth and the brown-tail moth*, U. S. Dept. Agr., Bur. Entom., Bul. 91, pp. 52, 62, 253–255, pl. 1 col. (1911).
Burgess, A. F., *Calosoma sycophanta*, *ibid.*, Bul. 101, 94 pp., 9 pls., 22 figs. (1911).
Burgess, A. F., and Collins, C. W., *The value of predaceous beetles in destroying insect pests*, U. S. Dept. Agr., Yearbook, 1911, pp. 463, 464, pls. 59–60 (1912).
The calosoma beetle (Calosoma sycophanta) *in New England*, U. S. Dept. Agr., Bul. 251, 40 pp., 8 pls., 3 figs. (1915).
The genus Calosoma, *ibid.*, Bul. 417, pp. 64–67, pls. 10–13 (1917). Complete bibliography.
Smith, H. S., Calif. State Hort. Com., *Mthly. Bul.*, vol. 2, p. 590 (1913); vol. 8, p. 46 (1919).

[33] Audouin, J. V., and Brullé, A., *Hist. naturelle des insectes*, t. 5, p. 92 (1835).

established and has become an important factor in the control of the moths in question.

Through the efforts of H. S. Smith, A. F. Burgess, and L. O. Howard, this beetle was introduced into California in April, 1913, and two other lots totaling 1,000 adults were secured in 1918. These were liberated in Sacramento for the brown day moth; on Angel Island, San Francisco Bay, for tent caterpillars; and in San Mateo County for the California oak moth. No reports have since been made as to whether or not the beetles have become established in any of these localities in California.

COCCINELLIDÆ (Family). Ladybird Beetles.[34]

Verania frenata (Erichson) [35] was collected in New South Wales by Albert Kœbele in 1891 and a lot of 175 adults were received by Coquillett in southern California, November 29, 1891. It was described by Kœbele as "the yellowish one with six elytral black spots" and preyed upon the cabbage aphis and the woolly apple aphis. It never became established in California.

The two-spotted ladybird, *Adalia bipunctata* (Linn.),[36] is a European and American species now listed from several states in North America, and appears to be widely distributed in this country. Say described it as *Coccinella bioculata* in 1824 from specimens taken in Indiana.[37] Its history in California is not fully known. In 1889, B. M. Lelong collected and sent three large colonies from the "Eastern States" to California.[38] These were probably liberated at Sacramento and in the San Francisco Bay region. At present this ladybird is very common in the latter region and feeds upon various species of aphis.

The seven-spotted ladybird beetle, *Coccinella septempunctata* Linn.,[39] is a very common aphis-feeding species occurring in Europe,

[34] See bibliography under parasitic Hymenoptera, pp. 323–324. Also see list of ladybird beetles introduced into California by A. Kœbele, pp. 367–370.

Froggatt, W. W., *Australian ladybird beetles*, Agr. Gaz. N. S. Wales, vol. 13, pp. 895–911, col. pl. 13 (1902).

[35] Erichson, W. F., *Wiegmann Arch.*, vol. 8, p. 195 (1842) (*Coccinella*).

Thompson, E. H., *Notes on Tasmanian Coccinellidæ*, Insect Life, vol. 6, p. 12 (1893).

Coquillett, D. W., U. S. Dept. Agr., Div. Entom., *Bul. 30*, pl. 13 (1893).

Wrongly listed as *Alesia fromata* (species misspelled).

[36] Linnæus, C., *Syst. Nat.*, p. 364 (1758) (*Coccinella*).

[37] Say, Thos., *Jour. Acad. Nat. Sci.*, Philad., vol. 4, p. 94 (1824).

[38] Craw, Alex., Calif. State Bd. Hort., *Rept. 1893–1894*, p. 98 (1894).

[39] Linnæus, C., *Syst. Nat.*, p. 365 (1758).

North Africa, Siberia, and India. Howard received living specimens from Europe which were sent to California and received by Craw,[40] Nov. 18, 1900, and liberated in Alameda and Santa Clara counties with colonies of the mealy plum aphis, *Hyalopterus arundinis* (Fabr.). H. S. Smith received several hundred specimens from H. Wichgraf, Germany, about 1916. It never became established in California and is not now recorded from any part of the United States.

The New Zealand ladybird beetle, *Coccinella novazealandica* Colenso, was brought to California from New Zealand where it feeds on cabbage aphis, by Kœbele on his return trip from Australia. Twenty-one adults were still alive when he liberated them at Alhambra, March 18, 1889.[41] It never became established in California.

Ptychanatis axyridis Pallas is a common and important ladybird beetle occurring in Eastern Siberia, Northern China, Manchuria, and Japan and has been described under no less than seventeen different names. It is an aphis-feeding species which was collected in Japan by C. P. Clausen and sent to the state insectary at Sacramento in June and July, 1916, and colonized in the Capitol Park.[42] It has not been noted since.

Leis antipodum (White) [43] is a variable species occurring in New Zealand and New South Wales, Australia. It was sent to California from New Zealand by Kœbele and was received by Coquillett in southern California, October 30, 1891. The adults did not feed upon any of the scales offered and died on Nov. 20, 1890, without having deposited eggs.[44]

The spotted ladybird, *Leis conformis* (Bdv.),[45] was one of the most important coccid- and aphis-feeding ladybird beetles occurring in Australia and Tasmania. In fact in the latter it is considered to be the most useful ladybird. Kœbele began sending specimens to

[40] Craw, Alex., Calif. State Bd. Hort., *8th Rept.*, 1901–1902, pp. 191, 200 (1902).
[41] Kœbele, A., U. S. Dept. Agr. Div. Entom., *Bul. 21*, p. 24, fig. 12 (1890).
[42] Smith, H. S., Calif. State Hort. Com., *Mthly. Bul.*, vol. 5, p. 350 (1916).
[43] White, A., *Ann. and Mag. Nat. Hist.* (2) vol. 1, p. 66 (1849) (*Coccinella*).
[44] Coquillett, D. W., U. S. Dept. Agr., Div. Entom., *Bul. 30*, pp. 10, 11 (1893).
[45] Boisduval, J. A., *Voy. de l'Astrolabe*, p. 604 (1835) (*Coccinella*).

Kœbele, A., *Rept. on the importation of parasites and predaceous insects*, Calif. State Bd. Hort., pp. 7–14, col. pl. 1, figs. 5–5b (1892).

Coquillett, D. W., U. S. Dept. Agr., Div. Entom., *Bul. 30*, pp. 12, 15, 22–24, 26 (1893); *Insect Life*, vol. 5, pp. 252–253 (1893); vol. 6, pp. 11, 24 (1893).

Thompson, E. H., *Notes on Tasmanian Coccinellidæ*, Insect Life, vol. 6, pp. 11–12 (1895).

Froggatt, W. W., *Agr. Gaz. N. S. Wales*, vol. 13, p. 902, col. pl. 13, fig. 5 (1902).

California on his second trip to Australia in 1892. Specimens were sent to B. M. Lelong and to Coquillett and were liberated (as indicated in the tabulation on p. 268) in the citrus orchards of southern California to prey upon red scale. But inasmuch as it was in such small numbers (2 specimens at a place) it is no wonder that the species never became established in the state. It apparently did not impress Compere, as he made no attempt to introduce it into the state.

The six-spotted ladybird beetle, *Chilomenes sexmaculata* (Fabr.),[46] is a widely distributed and common aphis-feeding species in India, Java, Borneo, Philippine Islands, Prince of Wales Island, Malay Peninsula, islands of Bali, Bouru, Flores, Sumatra, and Cape Town, South Africa. It is the commonest species in the plains of India. In 1912, P. H. Timberlake, Bureau of Entomology, received 30 specimens of this beetle from Florida where they had been brought by R. S. Woglum from India. He reared several thousands at Whittier, California, where they were liberated. He also sent specimens to E. K. Carnes at the State Insectary Capitol Park, Sacramento. From the thirty living adults received, 3,000 were reared. Distributions were made as follows: 1,975 larvæ and 100 adults in Capitol Park, Sacramento; and 275 larvæ at Palo Alto. Adults were recovered at Palo Alto the same year, but the insect never became established anywhere in the state.

Chilocorus bipustulatus (Linn.)[47] is an old world species occurring in southern Europe, northern Africa, Syria, and Persia, and feeds on various coccids. It was sent to H. S. Smith in California from Italy by F. Silvestri and G. Rossetti in 1915 and reared at Sacramento. Some seven hundred adults were colonized in the citrus orchards infested with the black scale and citricola scale at Fairoaks, Calif., on July 21 and Sept. 17, 1915. In 1927 Smith received additional material which was propagated for orchard colonization. Considerable numbers were liberated and the species persisted on citrus trees in Santa Barbara for over a year at least, but it has not been seen there lately and has never been recovered as yet at Fairoaks.

[46] Fabricius, J. C., *Species Insectorum*, p. 96 (1781) (*Coccinella*).
Maxwell-Lefroy, H., *Indian Insect Life* (Calcutta, Thacker, Spink & Co., 1909), p. 307, col. pl. 17.
Carnes, E. K., Calif. State Hort. Com., *Mthly. Bul.*, vol. 1, pp. 820–821 (1912).

[47] Linnæus, C., *Syst. Nat.*, 10th ed., p. 36 (1758) (*Coccinella bipustulata*).
Smith, H. S., Calif. State Hort. Com., *Mthly. Bul.*, vol. 4, pp. 523–525, 543, fig. 105 (1915).

Chilocorus circumdatus (Schœnherr)[48] is a tropical species known to occur in Ceylon, Neilgherries, China, and Sumatra. It was designated the purple scale ladybird because it preyed upon that coccid and was introduced into Hawaii from south China by Kœbele in 1895 and sent to California from Hawaii by Geo. Compere twice in 1899, but never became established.

The Asiatic ladybird beetle, *Chilocorus similis* Rossi,[49] has long been known as an important predator of the San José scale and other armored coccids. As a result of his investigations of the San José scale in China and Japan, Marlatt made several sendings of this bettle to the United States in 1902. From the two surviving individuals, 5,000 beetles were produced the first summer. Some colonies were liberated at Washington and others were sent out to several states while rearing was continued in the insectary. In Georgia, especially, the beetle thrived and in one orchard alone at Marshallville from 25,000 to 40,000 specimens were estimated to occur in July, 1902, while the breeding stock at Washington soon disappeared. Apparently none of these were sent to California.

In 1916 C. P. Clausen collected specimens at Yokohama which were sent to Smith at Sacramento and colonized in the Capitol Park there. A second lot of 45 adults were received from Clausen on June 3, 1923, and was increased to 115 in the laboratory on red scale, yellow scale, and San José scale. These were also liberated, but no further records have been made regarding them.

The four-spotted ladybird beetle, *Exochomus quadripustulatus* (Linnæus),[50] is a widely distributed species in the Old World known in Europe, North Africa, Syria, and Siberia. Since it was originally described by Linnæus in 1858, it has also been known as *E. distinctus* (Brull.), *E. floralis* Mots., and *E. ibericus* (Mots.). It is a coccid-feeder and was introduced into California by H. S. Smith with the aid of F. Silvestri and G. Rossetti, who collected specimens

[48] Schœnherr, C. J., *Synonymia Insectorum*, vol. 2, p. 152 (1808) (*Coccinella circumdata* Schœn.).

[49] Rossi, P., *Fauna Etrusca, etc.*, p. 68 (1790).

Marlatt, C. L., U. S. Dept. Agr., Bur. Entom., *Bul. 62*, pp. 65–69, figs. 11–12, pls. 7, 8 (1906); *Pop. Sci. Mthly.*, vol. 65, pp. 316–317, 1 fig., 1 pl. (1904).

Nakayama, S., Chilocorus similis *Rossi and its relation to scale insects in Japan*, Calif. Hort. Com., Mthly. Bul., vol. 1, pp. 932–936, fig. 291 (1912).

Smith, H. S., Calif. State Hort. Com., *Mthly. Bul.*, vol. 6, p. 350 (1916); vol. 12, p. 336 (1923).

[50] Linnæus, C., *Syst. Nat.*, ed. 10, p. 367 (1758) (*Coccinella*).

Smith, H. S., Calif. State Hort. Com., *Mthly. Bul.*, vol. 4, pp. 523–525, 543, figs. 106–107 (1915).

in Italy and forwarded them to this state. From the material received, 350 adults were recovered and liberated in citrus and olive orchards, infested with a variety of scale insects, at Fairoaks, Calif., Sept. 17, 1915. Smith reports it as having been recovered from Golden Gate Park, San Francisco, by F. L. Scott where it was later observed feeding on *Physokermes insignicola* (Craw) in October, 1928. In 1927 he secured additional material and propagated considerable numbers of them for additional orchard colonization, but with what success has not yet been determined. If it became established at Fairoaks this fact has never been reported as yet.

Hyperaspis japonica (Crotch)[51] (*Cryptogonus*) was received from C. P. Clausen, Yokohama, Japan, June 3, 1923. From the material 90 adults were recovered, but as it preys on wax scales, which were not available in California, the entire lot was lost.

Scymnus sp. was sent to California from Hawaii in 1918 by P. H. Timberlake to prey upon mealybugs,[52] but it has never been recovered in the field.

Scymnus binævatus Mulsant [53] is a very interesting and important mealybug-feeding ladybird beetle indigenous to South Africa. In the hope of finding a natural check for the grape mealybug, *Pseudococcus maritimus* (Ehrh.), and the citrophilus mealybug, *P. gahani* Green, an attempt was made to introduce this ladybird into California. The first attempts of E. W. Rust to send the beetle to California in 1921 failed, but late in 1921 he prepared a colony and left it in charge of C. W. Mally at Cape Town and then went ahead to Australia. Here he telegraphed to Mally to forward the colony to Australia, where he received it and after replenishing the supply of food, brought it on to California in person, arriving with 29 living adults in March, 1922. From this small beginning the number was increased within a year to 250,000, which certainly speaks well for the modern insectary methods employed at the Whittier laboratory. The first field liberations were made on March 23, 1922, on the property of Harrison and Albright, Spring Valley, San Diego County. By July 1, 1922, 121,000 adults were

[51] Crotch, G. R., *Rev. coleopterous family Coccinellidæ* (London, 1874), p. 203. Smith, H. S., Calif. State Dept. Agr., *Mthly. Bul.*, vol. 12, p. 336 (1923).

[52] Calif. State Hort. Com., *Mthly. Bul.*, vol. 8, p. 46 (1919).

[53] Mulsant, E., *Spec. des coléoptères trimères*, p. 975 (1850). Smith, H. S., Calif. State Dept. Agr., *Mthly. Bul.*, vol. 11, pp. 830–832 (1922); *The successful introduction and establishment of the ladybird,* Scymnus binævatus *Mulsant, in California*, Jour. Econ. Entom., vol. 16, pp. 516–518 (1923).

colonized in 34 localities in the state. In April 500 adults were liberated in a lemon orchard infested with the citrophilus mealybug at Santa Monica and were found abundant there a year later. In July, 1,500 adults were colonized on 40 acres of citrus trees infested with the citrus mealybug, from which none were afterwards recovered. In July, 1922, larvæ were observed at Alhambra feeding on the citrophilus mealybug and at Pasadena feeding on the citrus mealybug.

From colonies liberated on the grape mealybug in the San Joaquin and Sacramento valleys no recoveries were made up to 1923, although in that year it was recovered at Whittier, San Fernando, Santa Monica, and Riviera.

During this period the beetle was extensively reared by all of the insectaries in southern California and it was given an excellent opportunity to become established, which was thoroughly accomplished. It has done very good work in many localities and may be counted upon as a factor in the natural control of many species of mealybugs in California at this time.

Scymnus bipunctatus Kugelann [54] is a European ladybird beetle introduced from Manila, Philippine Islands, into California by George Compere in 1910, under the name, *Cryptogonus orbiculus*. About 1,000 adults were recovered from the material and these were largely distributed throughout southern California by Compere in person the same year and at once became established on the citrus mealybug in Ventura County.

It was again introduced from the same locality by H. S. Smith in 1913 and later identified as *Scymnus bipunctatus* Kugel., under which name it now goes. In June, 1914, a colony of several thousand adults, reared from Smith's material at the insectary in Sacramento, was sent to Alhambra for liberation. It reproduced slowly and was not seen for several years.

From this material the beetle was established at Alhambra and other localities in southern California, although it has been of little economic importance, due to the good work of the Sicilian mealy-

[54] Kugelann, J. G., *Schneiders Mag.*, vol. 5, p. 547 (1794).
Panzer, G. W. F., *Entomologia Germanica, etc.*, p. 149 (1795) (*Coccinella biverrucata* Panzer).
Essig, E. O., *P. C. Jour. Entom.*, vol. 3, pp. 390–395, figs. 134, 135C, 136B; *Inj. and Ben. Ins. Calif.*, p. 213, fig 207 (1913) (*Cryptogonus orbiculus* Gyll.); *Insects W. No. Am.*, p. 414, fig. 296 (1926).
Smith, H. S., *The progress of* Scymnus bipunctatus, Calif. State Hort. Com., Mthly. Bul., vol. 3, p. 535 (1914); vol. 4, p. 434 (1915).

bug parasite, *Leptomastidea abnormis* (Gir.), in reducing the citrus mealybug.

Mite-eating ladybird, *Stethorus vagans* (Blackburn),[55] was noted feeding upon mites or red spiders in western Australia by Geo. Compere in 1900, and a colony sent to California by him was received by Craw on Feb. 14, 1900. Two other colonies were received from the same source on Feb. 10 and March 18, 1901, and were liberated in the counties of Alameda, Colusa, Fresno, Merced, Los Angeles, Santa Barbara, San Diego, Santa Clara, Contra Costa, Sacramento, and Yolo. The ladybird found conditions congenial here and became established in many parts of the state and can often be found abundant feeding on red spiders. It was very abundant in the citrus orchards at Santa Paula, Ventura County, during the years 1909–1911. Its existence in the state at the present writing is doubted by members of the insectary staff, who think the species in question is the native, *Stethorus picipes* Casey.

Rhizobius[56] *debilis* Blackburn[57] was one of the most promising ladybird beetles noted near Sydney, New South Wales, Australia, by Kœbele, first in 1889 and again in 1892. Next to *R. ventralis* (Er.), it was the most numerous of the rhizobiids encountered by him. It was taken in connection with the ivy scale, *Aspidiotus hederæ* (Vall.), *Eriococcus leptospermi* Mask., *E. turgipes* Mask., *Monophlebus fuscus* Mask., *Rhizococcus araucariæ* Mask., and *Lecanium cassiniæ* Mask. Large numbers of the beetle were forwarded to California by Kœbele in 1892 and in the same year colonies placed in the olive orchard of Ellwood Cooper infested with black scale at Santa Barbara, were reported doing remarkably well. Two specimens placed on a prune tree infested with San José scale in Kœbele's yard at Alameda by Craw on May 14, 1892, were reported as having also done well. In August "larvæ of all sizes as well as imagoes were present, and these were found upon

[55] Froggatt, W. W., *Agr. Gaz., N. S. Wales*, vol. 13, pp. 909–910 (1902).
Calif. State Bd. Hort., *Seventh Ann. Rept.*, 1899–1900, p. 14, 1901; *ibid., Rept.*, 1901–1902, p. 196 (1902).
Essig, E. O., *Inj. and Ben. Ins. Calif.*, p. 220, fig. 219 (1913); ed. 2, p. 231, fig. 220 (*Scymnus*); *Insects W. No. Am.*, p. 413 (1926).

[56] Kœbele sent over a large number of species belonging to this genus, most of which died out immediately. See list on p. 367. Also see *Studies of parasitic and predace[illegible] insects in New Zealand, Australia, and adjacent islands*, U. S. Dept. Agr., pp. 32-[illegible] (1893).

[57] Kœbele, A., *Studies of parasitic and predaceous insects in New Zealand, Australia, and adjacent islands*, U. S. Dept. Agr., p. 33 (1893).
Craw, A., Calif. State Bd. Hort., *Rept. 1894*, p. 53 (1894).
Insect Life, vol. 6, pp. 28–29 (1893).

other trees as well during September." On August 16, 1893, the beetle was not so abundant when Craw and Kœbele again visited the Cooper olive orchard. It was still also evident in Kœbele's yard in August, 1893. In spite of these encouraging reports the beetle soon completely disappeared in California.

The black ladybird beetle, *Rhizobius ventralis* (Er.),[58] was first described by Erichson as *Scymnus ventralis* in 1842.

On his first trip to Australia Albert Kœbele collected this beetle at Adelaide, South Australia, in October, 1888, and included larvæ of it along with the first shipment of *Cryptochætum* (*Lestophonus*), which left Sydney in October and reached Coquillett in California in December, 1888.[59] Concerning this beetle Kœbele writes:[60] "Large numbers of Icerya were placed in this (Wardian shipping case), and such larvæ as were found feeding upon them, including *Scymnus* [*Rhizobius ventralis* (Er.)], only occasionally found with Icerya, yet very abundant on various Eucalyptus scales, especially on *Eriococcus eucalypti*. Of this I sent large numbers to California in my later shipments, as they were easily collected by the hundreds under bark of Eucalyptus infested with this *Eriococcus*. F. M. Webster brought me the same insect in numbers from Tasmania, together with the *Eriococcus* on Eucalyptus."

The many adults which reached California were not liberated and the few larvæ perished under a tent placed over a tree upon which the insects of this first shipment were released, as is revealed in the quotation further on.

[58] Erichson, W. F., *Beitrag zur Fauna von Vandiemensland, mit besonderer Rücksicht auf die geographische Verbreitung der Insecten*, Wiegmann Arch., vol. 8, p. 239 (1842).

Riley, C. V., *Insect Life*, vol. 5, pp. 127–128 (1892) (*Rhizobius ventralis* was described by David Sharp as *Scymnus restitutor* in *Insect Life*, vol. 1, p. 364 (1889) and went under this name for a brief time).

Calif. State Bd. Hort., *Rept.*, 1893–1894, pp. 426–432 (1894); *Sixth Bien. Rept.*, 1897–1898, pl. 1, figs. 4–6 (1889).

Froggatt, W. W., *Agr. Gaz. N. S. Wales*, vol. 13, pp. 906–907, col. pl. 13, fig. 16 (1902).

Isaac, John, *Bug vs. Bug.*, Calif. State Bd. Hort. First Bien. Rept., 1903–1904, col. pl. 4 (1905) (also issued separately in 1906).

Quayle, H. J., Calif. Agr. Expt. Sta., *Bul. 223*, p. 192, pl. 2, fig. 3 (1911).

Essig, E. O., *P. C. Jour. Entom.*, vol. 2, pp. 270–274, fig. 108 (1910); vol. 3, fig. 135A (1911).

Inj. and Ben. Ins. Calif., pp. 223–224, fig. 222 (1913); ed. 2, p. 229, fig. 215 (1915).

Insects of Western N. Am. (Macmillan, N. Y., 1926), pp. 418–419, figs. 290G, 302.

Compere, H., Calif. State Dept. Agr., *Mthly. Bul.*, vol. 9, pp. 454–458 (1920).

In Australia this beetle is called the eriococcus ladybird.

[59] See cottony cushion scale, p. 123.

[60] *Rept. of a trip to Australia to investigate the natural enemies of the fluted scale,* U. S. Dept. Agr., Div. Entom., Bul. 21, p. 14, fig. 5 (1890).

On his second trip to Australia in 1891–1892, Kœbele recognized the value of this beetle and again sent it to California, but only about twenty adults were available for liberation. His description of its occurrence in its native home is worthy of reproduction here and is as follows:[61]

Rhizobius ventralis Erich.—One of the most numerous of all the Coccinellidæ in South Australia and Victoria, becoming more rare toward Queensland. During my former trip I have actually seen these beetles by the handfuls sitting under bark of Eucalyptus that was infested with *Eriococcus eucalypti* Mask., upon which they feed, at Melbourne and Adelaide. I did not recognize the insect at first on this last trip at Sydney, where they were found upon various *Lecanium*, on citrus, and on other trees; in fact, the larvæ feeding upon these are much lighter in color than those feeding on *Eriococcus*. I saw in this the most effective enemy for all our *Lecanium* and a good supply of the mature beetles was sent to California by every steamer. Hon. Ellwood Cooper, who received the insects on two occasions, has in both instances succeeded in introducing the same upon *L. oleæ*. On a visit to his orchard on September 4, 1892, larvæ of all sizes as well as mature insects could be found in numbers at both places where they had been liberated. Large numbers of these beetles were sent over here on my former trip, and Prof. Webster also brought a number of them from Tasmania, all of which were sent to Los Angeles, yet none of them were liberated at that nor apparently this time. The beetles were met with feeding upon all species of *Lecanium* upon citrus trees; upon *Lecanium* sp. on guava at Harwood, New South Wales, where two other species of *Rhizobius* were also present; upon *Banksia serrata* infested with *Fioirina* (?) and *Chionaspis eugeniæ* Mask.; at Mount Victoria upon *Eriococcus leptospermi* Mask., upon *Leptospermum lævigatum* F. V. Müller; at Whitton, New South Wales, upon *Casuarina* and feeding here upon "*Gossyparia*, n. sp. or *Rhizococcus* (?) Maskell," also breeding upon *Rhizococcus araucariæ* Mask., on *Araucaria excelsa* R. Brown, at Sydney. But the chief food seems to be the various *Eriococcus* in Australia. It was this species and *R. debilis* Blackb., that freed a large tree in the botanical gardens at Sydney within a comparatively short time of a soft species of *Lecanium* that was covering the leaves, and shortly after all the *Rhizococcus* upon an Auraucaria close by were devoured by them. At the same place this insect was also numerous upon *Lecanium cassiniæ* Mask., on oleander. The larva of this beetle is preyed upon by a parasite, which at times destroys the greater part of them. Fortunately, by a provision of nature this parasite is kept in check by secondary parasites. Twenty-one larvæ of this beetle collected at Melbourne under bark of Eucalyptus infested with *Eriococcus*, upon which they had fed, were parasitized by eighty-four larvæ of *Homalotylus* sp.; of these but fifteen parasites issued, while all the rest were destroyed by two species of secondary parasites. Should the parasite ever appear on the *Rhizobius* larva in California, which would render its value as an enemy to scale insects of much less importance, we could

[61] Kœbele, A., *Studies of parasites and predaceous insects in New Zealand, Australia and adjacent islands*, U. S. Dept. Agr., pp. 32–33 (1893).

easily and with advantage introduce these secondary parasites by simple shipping over a few hundred infested larvæ of the *Rhizobius* or puparias of the *Homalotylus*. It is possible, but not likely, since we have no *Rhizobius* in this country, that the parasite was introduced on my former trip to Australia, as at that time a few larvæ of this beetle were sent over here, but all these were kept confined in a tent with *Icerya*, upon which they failed to feed, and all perished. Had the beetle been introduced three years ago they would now be present in the state by the million.

Near the end of May, 1892, Ellwood Cooper[62] received a few pairs of living adults and liberated them in his olive orchard which was infested with black scale. This lot was followed by another later. On a visit to the orchard on September 4, 1892, Kœbele found the beetle well established, there being an abundance of larvæ and adults present. In August of the next year, 1893, Kœbele again visited the orchard and found the beetle had increased enormously. His enthusiasm is expressed as follows: "The beetles are present in such numbers, however, that it will be but a few weeks until the whole orchard will be clean. The upper orchard, where beetles were liberated at the end of May of last year, is practically free of scales, and from here the Rhizobius have spread to the central orchard and can be found by the hundreds upon every tree. The beetles were seen in copulation everywhere, and on nearly every branch the females were seen thrusting their eggs under the old scales. It will be but a very short time until every tree is clean of scales, and no time should be lost in collecting and distributing this valuable insect to all parts of the state."[63] In September the distribution of colonies began and continued until October 16 "after 453 colonies of from 25 to 50 beetles each" had been sent out. Ellwood Cooper claimed an annual saving of from $3,000 to $5,000 because of it.[64]

The first success of this beetle caused a genuine feeling of confidence in the biological control method. Added to that already accomplished by the vedalia, it created a tremendous interest in the introduction of natural enemies of the common destructive scale insects. The black scale had become widely distributed and very injurious, but the new ladybird beetle was expected to immediately reduce it to negligible numbers if not to exterminate it altogether.

[62] Calif. State Bd. Hort., *Fourth Bien. Rept.*, 1892–1894, pp. 102–103, 426–432 (1894); *Insect Life*, vol. 5, p. 207 (1893).

[63] *Insect Life*, vol. 6, p. 29 (1893).

[64] A complete list of these colonies is given in the *Fourth Biennial Report*, Calif. State Bd. of Hort., 1893–1894, pp. 5, 436–437 (1894).

With this in mind Cooper, Kœbele, Craw and others gave it unqualified praise and recommendations.

By 1894 it had gained so much fame that Cooper's orchards were visited by many notables, including state and county officials, to view the work of the beetle at first hand. In addition to 825 colonies sent out by mail, Cooper furnished great numbers to those who called at his orchard for them. In all he estimated that over 1,000,000 adults were collected and distributed in the fall of that year. Cooper pronounced his orchards entirely free of black scale at that time.[65]

In 1895 Cooper[66] made this encouraging report relative to it: "I have to report that in Santa Barbara County the Rhizobii have been most successful in destroying the black scale, the apricot scale, the brown scale, the aphis on the walnut and on the orange, and the aphides generally that feed upon plant life. Freedom from these enemies is reported from every place where they have been successfully colonized. There are one or two orchards where the managers are antagonistic to this mode of warfare, and who continue to spray and fumigate. The orchards under their control are black, smutty, stunted, and present most striking evidence in favor of parasites. The orchards adjoining, where the Rhizobii have been colonized, are almost free from insect pests and in beautiful condition. This is so notorious that it is the common talk of all the fruit growers in the community."

With such recommendations it is not surprising that fruit growers soon began to complain about the inefficiency of the black ladybird. In fact as early as 1894, "The opinion was expressed at the meeting of the Pomological Society at Pasadena that the black ladybird was not showing up in the orchards in which colonies had been placed."[67] The beetle did become established over much of the southern and central parts of the state and in 1894 was known to occur in Los Angeles, Riverside, Santa Barbara, Ventura, San Bernardino, Santa Cruz, San Diego, and Napa counties.[68] It has since occupied practically all of the state except the northern portion. However, it has never been an effective enemy of the black scale or any other pest in any locality in the state. Repeated

[65] Calif. State Bd. Hort., *Rept. 18th Fruit Growers' Conv.*, p. 180 (1895).
[66] Calif. State Bd. Hort., *Rept. 19th Fruit Growers' Conv.*, p. 7 (1896).
[67] *Insect Life*, vol. 7, p. 48 (1894).
[68] Calif. State Bd. Hort., *Rept. 18th State Fruit Growers' Conv.*, pp. 181–183 (1894).

attempts have been made to concentrate it in great numbers in certain restricted areas to test the possibilities of mass production and liberation.

In 1920 some 4,000,000 adults were collected in Los Angeles County and liberated in Ventura County. Of these 1,048,200 adults were collected and colonized by S. H. Essig in the orchards of the Limoneira Company at Santa Paula in the same county.[69] In 1922–1923 S. H. Essig, superintendent of the insectary of the San Gabriel Valley Pest Control Association, collected and liberated in the orchards of the six citrus associations between Alhambra and Sierra Madra 481,000 adults with a view to the control of the black scale as an adjunct to the liberation of 2,445,425 adult *Metaphycus lounsburyi* (Howard). During the period from 1918–1923 the State Insectary collected and distributed adults as follows:[70]

1918–1919	250
1919–1920	23,403
1920–1921	34,120
1921–1922	6,985
1922–1923	23,550
Total	88,308

The results were so unsatisfactory in all of the cases cited above that the question of utilizing *Rhizobius ventralis* (Er.) as a factor in the commercial control of the black scale in California has been dropped for the time being.

Blaisdell's ladybird, *Lindorus lophanthæ* (Blaisdell),[71] was collected by Kœbele in Victoria, New South Wales, Queensland, where the larvæ were observed feeding upon ivy scale, *Aspidiotus hederæ* (Vall.), and red scale, *Chrysomphalus aurantii* (Mask.). It was sent to southern California in 1892 and apparently became established at once, although no records are available regarding its colonization and distribution.

[69] Calif. State Dept. Agr., *Mthly. Bul.*, vol. 9, p. 457 (1920).
[70] *Ibid.*, vol. 12, p. 341 (1923).
[71] Blaisdell, F. E., *Entom. News*, vol. 3, p. 51 (1892) (*Scymnus*).
Riley, C. V., *Insect Life*, vol. 5, pp. 127–128 (1892).
Kœbele, A., *Studies of parasitic and predaceous insects in New Zealand, Australia and adjacent islands*, U. S. Dept. Agr., p. 34 (1893) (*Rhizobius toowoombæ* Blackburn).
Tryon, H., *Rept. on insects and fungus pests*, no. 1, Queensland Mus., p. 131 (1889).
Craw, A., Calif. State Bd. Hort., *Rept.*, *1893–1894*, p. 102 (1894).
Essig, E. O., *P. C. Jour. Entom.*, vol. 3, pp. 518–519, fig. 166B (1911); *Inj. and Ben. Ins. Calif.*, p. 224, fig. 223 (1913), ed. 2, pp. 225–226, fig. 210; *Insects W. No. Am.*, p. 418, fig. 301 (1926).

In January or February, 1892, Blaisdell found this beetle preying upon the San José scale at Coronado Park, San Diego, and described it as *Scymnus lophanthæ*. In commenting upon this Riley states: "The beetle and its larva are quite abundant in the Coronado parks, according to Dr. Blaisdell; and since it also occurs near Los Angeles, there can be no doubt this useful little coccinellid has fully established itself in southern California." Craw believed that it occurred in the state previous to the introduction by Kœbele, but he may have had it confused with a different native species, *Scymnus marginicollis* Mann.

Anyway the beetle has become well established throughout much of middle and southern California and preys chiefly upon a large number of armored scale insects, including the greedy scale, ivy scale, San José scale, red scale, yellow scale, purple scale, Mediterranean fig scale, and rose scale. H. S. Smith reports that he has not been able to propagate this ladybird beetle upon mealybugs and very unsatisfactorily upon black scale.

The vedalia, *Rodolia cardinalis* (Mulsant) (Fig. 108), was described as *Vedalia cardinalis* by Mulsant in 1850.[72] It attracted little or no attention until it was discovered by Albert Kœbele "feeding upon a large female *Icerya*" *purchasi* Mask. in a garden in North Adelaide, Australia, October 15, 1888.[73] It was later observed at Mannum on October 18th where "all scales here, as well as all the predacious larvæ found feeding upon them, were collected and taken to Adelaide to be shipped to California, together with those found at the latter place." [74] Kœbele was specially

[72] Mulsant, E., *Spec. des col. trimères sécuripalpes*, Ann. Soc. d'Agric., Lyon (2), vol. 2, p. 906, 2 (1850).

Coquillett, D. W., *The imported Australian lady-bird*, Insect Life, vol. 2, pp. 70–74, figs. 9–10 (1889).

Froggatt, W. W., *Agr. Gaz. N. S. Wales*, vol. 13, pp. 905–906, col. pl. 13, fig. 15 (1902).

Calif. Hort. Com., *First Bien. Rept.*, 1903–1904, pp. 80–82, col. pl. 1, figs. 4–4b (1905).

Riley, C. V., *Insect Life*, vol. 6, pp. 135–139 (1893).

Kœbele, A., *Studies of parasitic and predaceous insects, etc.*, U. S. Dept. Agr., p. 29 (1893).

Calif. State Bd. Hort., *Ann. Rept.*, 1889, pp. 260–271, col. pl. 4 (1890). (Full history of importations and distribution.)

Howard, L. O., and Fiske, W. F., U. S. Dept. Agr., Bur. Entom., *Bul. 91*, pp. 24–30, fig. 4 (1911).

Essig, E. O., *Ins. Western N. Am.* (Macmillan, N. Y., 1926), pp. 415–418, figs. 290k, 298, 299.

In Australia this beetle is commonly called the icerya ladybird.

[73] Kœbele, A., U. S. Dept. Agr., Div. Entom., *Bul. 21*, p. 12, figs. 2–3 (1890).

[74] Kœbele, A., *op. cit.*, p. 13.

instructed to collect the dipterous parasite of the cottony cushion scale and gave most of his attention to that. Although he collected and sent back a considerable number of the vedalia he wrote little concerning it so that most of the information was given by Coquillett who received and cared for them in California. The history of the first introductions is given by him as follows:[75]

The first consignment of these Lady-birds reached me on the 30th of November (1888), and numbered twenty-eight specimens; the second consignment of forty-four specimens arrived December 29; and the third consignment of fifty-seven specimens reached me on January 24, making one hundred and twenty-nine specimens in all. These, as received, were placed under a tent on an Icerya-infested orange tree, kindly placed at my disposal by J. W. Wolfskill, of this city. Here they were allowed to breed unmolested, and early in April it was found that nearly all of the Iceryas on the inclosed tree had been destroyed by these voracious Lady-birds. Accordingly, on the 12th of April, one side of the tent was removed, and the Lady-birds were permitted to spread to the adjoining trees. At this date I began sending out colonies to various parts of the state, and in this work have been greatly aided by Wolfskill and his foreman, Alexander Craw, both of whom were well acquainted with the condition of the orchards in this part of the state. By the 12th of June we had thus sent out 10,555 of these Lady-birds, distributing them to two hundred and eight different orchardists; and in nearly every instance the colonizing of these Lady-birds on Icerya-infested trees in the open air proved successful. The orange and other trees—about seventy-five in number—and also the shrubs and plants growing in Wolfskill's yard, have been practically cleared of Iceryas by these Lady-birds, and the latter have of their own accord spread to the adjoining trees to a distance of fully three-fourths of a mile from the original tree.

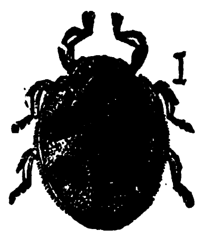

FIG. 108.—One of the first illustrations of the vedalia, *Rodolia cardinalis* (Mulsant), used by Albert Kœbele in 1890.

Besides the three consignments of these Lady-birds referred to above I also received two later consignments. The first of these reached me February 21, and numbered thirty-five specimens; these I colonized on an Icerya-infested orange-tree in the large orange grove belonging to J. R. Dobbins, of San Gabriel. The last consignment of three hundred and fifty specimens arrived March 20; one-third of these I left with Dobbins, while the remainder I colonized on orange-trees in the extensive grove owned by Messrs. A. B. and A. Scott Chapman, in the San Gabriel Valley. All of these colonies have thrived exceedingly well. During a recent visit to each of these groves I found the Lady-birds on trees fully one-eighth of a mile from those on which the original colonies were placed, having thus distributed themselves of their own accord. The trees I colonized them on in the grove of Dobbins were quite large and

[75] Coquillett, D. W., *op. cit.*, pp. 73–74 (1889).

were thickly infested with the Iceryas, but at the time of my recent visit scarcely a living Icerya could be found on these and on several of the adjacent trees, while the dead and dry bodies of the Iceryas still clinging to the trees by their beaks, indicated how thickly the trees had been infested with these pests, and how thoroughly the industrious Lady-birds had done their work.

By July, 1889, the vedalia had increased enormously in the Dobbins' orchard. A letter from Dobbins[76] dated July 2, 1889, states: "People are coming here daily, and by placing infested branches upon the ground beneath my trees for two hours, can secure colonies of thousands of the Vedalia, which are there in countless numbers seeking food. Over fifty thousand have been taken away to other orchards during the past week, and there are millions still remaining, and I have distributed a total of sixty-three thousand since June 1. I have a list of one hundred and thirty names of persons who have taken colonies, and as they have been placed in orchards extending from South Pasadena to Azusa, over a belt of country ten miles long and six or seven in width, I feel positive from my own experience, that the entire valley will be practically free from *Icerya* before the advent of the New Year." (Dobbins originally received three small colonies of vedalia; one on February 22 and the other two on March 20th.)

On October 22, 1889, Dobbins distributed over 120,000 vedalias to 226 fruit growers in southern California.[77]

The vedalia was also propagated by the Los Angeles County Board of Horticultural Commissioners for distribution. W. A. Henry, of Madison, Wisconsin, who visited California at the time, graphically describes the methods used:[78]

In studying this insect (cottony cushion scale) we first visited the place of William Niles, in Los Angeles, where the 'lady-bug' (*Vedalia cardinalis*) was being propagated by the county insect commission for dissemination among the orange groves infested with the cottony cushion or white scale. We found five orange trees standing about 18 feet high inclosed by walls of cheap muslin supported by a light frame-work of wood. The orange trees inside this canvas covering had originally been covered with the white scale, but the Vedalia which had been placed on these trees were rapidly consuming the last of the pests. Entering one of these canvas houses we found the Vedalia, both larvæ and adults, busy consuming the scale; here and there on the canvas were the beetles endeavoring to escape to other trees. These insectaries were in charge of Kercheval, one of the county insect commissioners, who kept a record of the distribution of the beetle. It was indeed a most interesting

[76] Dobbins, J. R., *Insect Life*, vol. 2, p. 112 (1889).
[77] *Ibid.*, p. 191 (1889).
[78] *Ibid.*, p. 142 (1889).

sight to see the people come, singly and in groups, with pill-boxes, spool-cotton boxes, or some sort of receptacle in which to place the Vedalias. On application they were allowed within the insectaries and each was permitted to help himself to the beetles, which were placed in the boxes and carried away to be placed on trees and vines infested by the white scale at their homes. Mr. Kercheval kept a record of the parties and the number of beetles carried off. The number coming for the Vedalia was surprisingly large—scores in a day—and each secured at least a few of the helpful beetles. That the supply should hold out under such a drain was a great surprise, and speaks better than words the rapidity with which the Vedalia multiplies when there are scale insects enough to nurture the young.

Although the introduction of the vedalia was one of the greatest accomplishments of the Bureau of Entomology, the total cost was approximately only $1,500.[79]

During the winter of 1889–1890 the vedalia disappeared completely in many localities and it was feared that it could not stand the winter climate in California. This concern is indicated by the fact that at a meeting held on August 14, 1890, the California State Board of Horticulture resolved to build two glass houses, each covering a large orange tree colonized with the cottony cushion scale, as a winter refuge for the ladybird beetles and as a means of preserving some of them in this way. These houses (Fig. 120) were octogonal in shape, 16 feet in diameter and 18 feet in height. They were constructed so as to present as much surface as possible to the sun and the ventilators were screened with fine brass wire mesh to make them insect tight. They were erected on the property of J. R. Dobbins at San Gabriel at a total cost of $650.15. Dobbins took charge of the houses for the state and assumed all the running expenses in connection therewith.

It was soon evident that such winter protection for the vedalia was unnecessary. In 1889 it was stated that the two glass houses were to be moved to the State Capitol, Sacramento, but apparently this plan was never carried out. The final disposition of the houses is not recorded.[80]

On Kœbele's second trip to Australia in 1891–1892 he found the vedalia in New Zealand and in many places in Australia, and collected a colony in New Zealand and shipped it to Cape Town, South Africa, from Sydney, Jan. 30, 1892, but it was unnecessary to send any more to California.

[79] *Ibid.*, vol. 4, p. 226 (1892).

[80] Calif. State Bd. Hort., *Ann. Rept.*, 1890, p. 468, pl. (1890); *Rept. 1891*, p. 11 (1892).

The introduction of the vedalia and other natural enemies of the cottony cushion scale, has not been the means of exterminating the destructive coccid in California, but it furnished to the world the first demonstration of effective natural control and was responsible for the biological control of insects now being successfully carried on in many parts of the world. Occasionally in California the scale appears in isolated places in sufficient numbers to be destructive, when a few of the vedalia are captured and liberated in the infested areas. For such purposes the State Insectary usually propagates enough of the ladybird beetles to supply the demands of the growers. Some of the records of such distributions are:

1903–1904	182 colonies,	2,730 adults
1917–1918		211 "
1918–1919		100 "
1920–1921		2,505 "
1921–1922		4,660 "
1922–1923		25,850 "

The figures might lead to the conclusion that the cottony cushion scale was on the increase, but the facts are that the fruit growers are becoming more alert and are relying more upon biological control and therefore continually making greater demands upon the insectaries of the state. The above figures do not mean much because no accurate figures were kept of the exact numbers distributed from Sacramento.

Kœbele's ladybird, *Novius kœbelei* (Olliff),[81] was taken by Kœbele at Parramatta, New South Wales, Australia, October 28–29, 1891,[82] on his second trip to Australia. At Toowoomba, on Nov. 11–12, 14, 1891, eggs and larva were found on the cottony cushion scale, the latter feeding upon the scale and in the egg sacs. The beetle was also taken at Brisbane. In the collections at Sydney, A. S. Olliff had a single specimen, and H. Tryon, Brisbane, had two more, showing that it had been discovered before Kœbele's visit. However, no description was drawn until after Kœbele's

[81] Kœbele, A., *Rept. on the importation of parasites and predaceous insects*, Calif. State Bd. Hort., pp. 7–12, col. pl. 1, figs. 3–4b (1892).
Craw, A., Calif. State Bd. Hort., *Fourth Bien. Rept.*, 1893–1894, p. 101, pl. 1 (1894); *Sixth Bien. Rept.*, 1897–1898, pl. 1, figs. 1–3 (1899).
Calif. State Hort. Com., *First Bien Rept.*, 1903–1904, col. pl. 1, figs. 1–1c (1905).
Essig, E. O., *Ins. Western N. Am.*, p. 418, fig. 300.

[82] Kœbele, A., *Studies of parasitic and predaceous insects, etc.*, U. S. Dept. Agr., pp. 29–30 (1893).

specimens had been submitted, when in 1893, Olliff named it *Vedalia kœbelei*[83] in honor of its new collector.

The first consignment of this beetle, accompanied by a letter dated Sydney, Australia, November 29, 1891, reached Coquillett at Los Angeles, December 28, 1891. Regarding this beetle Kœbele stated: . . . "Box '*Vedalia* sp., Toowoomba, Parramatta.' Try and breed this little beetle on *Icerya*. It is the insect destroying this scale here and at Queensland. They will readily lay their eggs in a large glass jar if supplied with scales."[84] Only three adult beetles reached Coquillett, which were placed in a jar with *Icerya* as directed. From these Coquillett reared the adults which were liberated in the orchards and became generally distributed throughout southern California, although never as widely scattered or as numerous as the vedalia. Specimens of this beetle were also collected in Australia by Geo. Compere and sent to California in 1900. It proved to be a very good predator and often did as remarkable work in destroying the cottony cushion scale as did the vedalia, although the credit was nearly always given to the latter. During the spring of 1911 a considerable outbreak of the cottony cushion scale occurred in the 40-acre lemon orchard belonging to the Teague Lemon Company, west of Santa Paula. S. H. Essig set about to collect ladybirds to destroy the scale, but at that time could only find *Novius kœbelei* which he collected in considerable numbers in various parts of Ventura County. It took several weeks to secure enough to complete the experiment. However, the beetle propagated remarkably well and by winter there were thousands present and the scale was reduced to insignificance. The results were exactly what one would expect from the vedalia. Without any artificial propagation of any sort it is still to be found in southern California. In October, 1929, H. S. Smith reported to me that he has never been able to find a single specimen of this beetle in southern California for years. However, it hardly seems possible that it has completely disappeared since 1911.

The mealybug destroyer, *Cryptolæmus montrousieri* Mulsant (Fig. 109), was originally collected in Australia and described from the collection of A. Deyrolle and B. P. Perroud by Mulsant in

[83] *Insect Life*, vol. 4, p. 289 (1892).
[84] Coquillett, D. W., U. S. Dept. Agr., Div. Entom., *Bul. 30*, p. 12 (1893).

1853.[85] It was collected by Kœbele on his second trip to Australia in 1891–1892 and sent to California during that time. Concerning it Kœbele writes:[86]

One of the most numerous and useful insects for various coccids, but especially the various Mealy Bugs (*Dactylopius*).

The beetle is very common in Queensland and also in New South Wales, and may be found upon almost any shrub or tree infested with these latter scales. At Brisbane its larvæ were seen by the thousands, both on my former and last trips, upon the bunya-bunya trees, *Araucaria bidwilli* Hooker, and feeding here upon *Dactylopius aurilanatus* Mask., a coccid introduced into New Zealand, where it is very numerous upon these trees and has as yet no enemies. The introduction of this beetle in that as well as any country would be highly advisable and we could find no better natural enemies for the greenhouse pests, where this beetle would prosper and keep the plants free from the Mealy Bugs and Black Scale. Mr. H. Tryon,[87] in speaking of the beneficial work of the Coccinellidæ, remarks of this very insect: "To mention but a single instance, that of a small black beetle reddened at each extremity, belonging to the group Scymnides and named *Cryptolæmus*. The larva of this is a small active grub, measuring about one-quarter of an inch in length, covered above with six rows of contiguous, elongated, white, mealy, secreted appendages. Quite recently the bunya-bunyas and other auricaratious trees growing about Brisbane have been infested by a coccus insect, an apparently undescribed species of *Dactylopius*, which affects especially the spot where the leaves and branches unite, and the parasites were at one time so numerous that the death of this valuable tree from their attacks seemed very imminent. However, the *Cryptolæmus* beetle also visited the Araucarias and in some places its larvæ occurred in such profusion that the trunks of these trees and the ground around their bases looked as if flour had been dusted in patches here and there upon them. Both in its adult and larval condition it waged war upon the coccid insects, and as a result these trees are saved from destruction. This friendly insect is none other than the one which is met with on

[85] Mulsant, E., *Opuscules entomologiques*, Cah. 3, pp. 140–141 (1853). Specific name *montrousieri* not *montrouzieri*. Named for M. l'abbe P. Montrousier, a missionary of the Society of Maristes, a distinguished entomologist and author of the Fauna of Woodlark Island (1857), a small island near New Guinea. He also wrote on the Fauna of New Caledonia.

Calif. State Bd. Hort., *Sixth Bien. Rept.*, 1897–1898, pl. 3, figs. 1–4 (1899).

Froggatt, W. W., *Agr. Gaz. N. S. Wales*, vol. 13, pp. 907–909, col. pl. 13, fig. 13 (1902).

Despeissis, A., *Jour. Dept. Agr.*, W. Australia, vol. 5, pp. 248–249 (1902); vol. 9, p. 39, pl. (1904).

Essig, E. O., *P. C. Jour. Entom.*, vol. 2, pp. 263–270, figs. 106–107 (1910); vol. 3, figs. 135A–136A (1911).

Inj. and Ben. Insects Calif., pp. 214–215, figs. 208–209 (1913); ed. 2, pp. 222–223, figs. 205–206 (1915).

Insects Western N. Am., p. 415, figs. 290I, 297.

In Australia this beetle is commonly called the araucaria scale ladybird.

[86] Kœbele A., *Studies of parasitic and predaceous insects in New Zealand, Australia, and adjacent islands*, U. S. Dept. Agr., pp. 27–28 (1893).

[87] *Rept. on insect and fungus pests*, Queensland Mus., p. 16 (1889).

various native trees, especially acacias, and also on the citrus and other economic plants of our gardens. These it also visits for the purpose of ridding them or at least checking the increase of the various scale insects, especially those belonging to the Lecanidæ, which infest these trees, and this pest it literally mows down to the surface of the leaves, so great is its voracity."

The insect was met with in almost all places visited, and breeding, besides, upon all the mealy bugs (*Dactylopius*), on various species of *Lecanium*, *Eriococcus* (n. sp. Maskell), upon *Casuarina* at Whitton, New South Wales, upon *Eriococcus leptospermi* Mask., around Sydney and Mount Victoria, upon *Eriococcus tepperi* Mask., on *Eucalyptus* at Parramatta, and upon *Rhizococcus araucariæ* Mask., on *Araucaria excelsa* at Sydney. A large bush of Eucalyptus badly infested with *Eriococcus tepperi* was a favorable "hunting ground" for gathering eggs and larvæ of *Eublemma* (*Thalpochares*) *cocciphaga* Meyr., and when these beetles with their voracious appetite appeared upon the bush it was soon clear of all coccids.

While the work of these larvæ upon soft coccids is something remarkable, when it comes to the harder insects, as for instance *Lecanium*, it is by no means so effective. The beetle was repeatedly bred in confinement in large numbers, in the hope of rearing parasites from the larvæ, but I failed to do so, and this may be one of the very few coccinellid larvæ of Australia that are not attacked by internal parasites. The white, powdery covering of the larvæ is no doubt a protection against the enemies; in fact the larvæ with its covering mimics many scales upon which it feeds.

The beetles were sent over here by every steamer from Australia and should be introduced. I look for their appearance at Ellwood Cooper's place, who received some and liberated them upon the black scale. Coquillett, who received the most, informed me of having sent the living beetles to Washington. The beneficial work of this beetle could not be estimated in some of the tropical countries, such as the Hawaiian Islands, which abound with Dactylopidæ and Lecanidæ. The insect was also found in New Caledonia upon *Lecanium longulum* Douglas, on guava, and upon *Lecanium cassiniæ* Mask., on oleander.

Apparently the first specimens reached California in December, 1891, and others followed the next year. While the beetle did not become established on the black scale in the olive orchards of Ellwood Cooper at Santa Barbara, it did become colonized in many parts of southern California, particularly in San Diego County where it persisted long after it had disappeared in practically every other locality.

In 1907 Ehrhorn [88] referred to it as follows: "An imported species which is the enemy of several species of mealy bugs is *Cryptolæmus montrousieri*. This species has been tried in various sections of the state, but has not been successful everywhere. In the most southern

[88] Ehrhorn, E. M., Calif. State Hort. Com., *Proc. 33d State Fruit Growers' Conv.*, p. 152 (1908).

portions of the state it can be found at times in numbers and has been doing good work, yet it has not been as satisfactory nor has

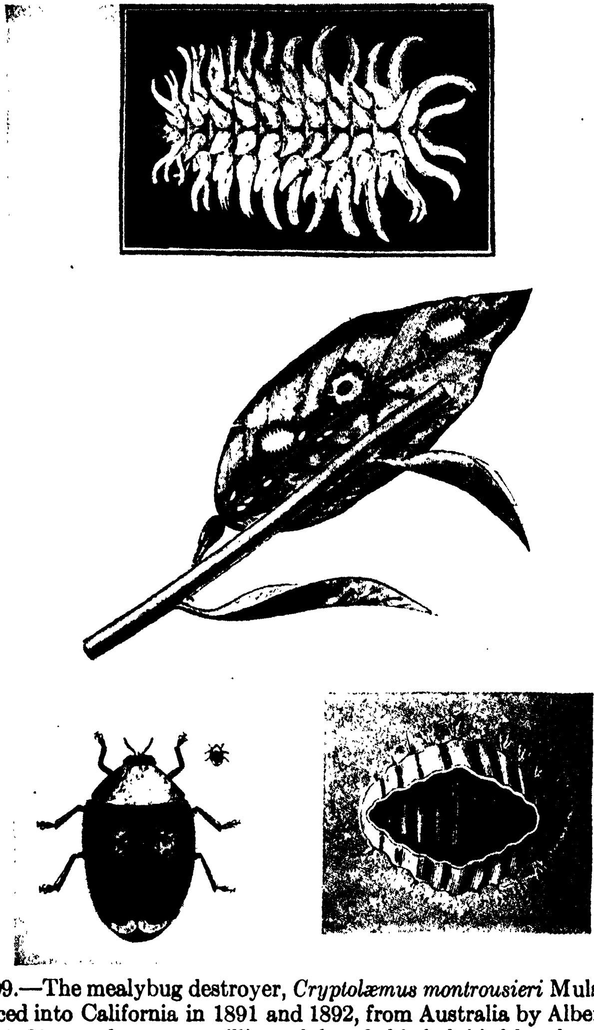

FIG. 109.—The mealybug destroyer, *Cryptolæmus montrousieri* Mulsant, introduced into California in 1891 and 1892, from Australia by Albert Kœbele. In 1928 over forty-two million adults of this ladybird beetle were propagated and liberated into the citrus orchards of southern California for the commercial control of mealybugs. (Calif. State Bd. Hort., 1899.)

it done the work of eradication with us as it has in the Hawaiian Islands on the coffee. There, it is claimed, it has practically freed the coffee plantations from the mealy bug. In confinement, with

plenty of food, it does fairly well, and there must be some cause which prevents its becoming more numerous."

Outside of San Diego County little or no attention was given to this predator until 1908 when the citrus mealybug was found to be a serious pest of citrus trees at Santa Paula, Ventura County. The newly appointed secretary of the County Board of Horticultural Commissioners, P. E. Smith, secured a large number of living adults from F. Austin, secretary of the County Board of Horticultural Commissioners of San Diego County, during the spring and summer of 1909.[89]

In the summer and fall of 1909, as an inspector under Smith, I had an opportunity to investigate the work of this beetle in the Blanchard orchards at Santa Paula. It increased rapidly during the summer and the trunks of trees badly infested with mealybug were often almost completely covered with the larvæ and pupæ of the *Cryptolæmus*. But during the following winter most of the ladybird beetles disappeared, so that very little was accomplished by them the next year. In San Diego County conditions for the propagation of the beetle appears to have been more favorable as indicated by a letter from R. C. Allen, of Bonita, dated Jan. 2, 1909.[90]

> In consequence of its remaining on the trees throughout the winter, the *Cryptolæmus* increased very considerably, so that last summer, . . . it was present in immense numbers. When fumigating last fall, I set aside three patches of about an acre each in different parts of the orchard where the mealybug was bad and the *Cryptolæmus* most abundant. I did this for the purpose of preserving and multiplying the latter. In this we were very successful, and after the orchards had been fumigated the *Cryptolæmus* seemed to spread pretty well over them. At the present time there is very little mealybug to be seen, and the general condition of the orchards in that respect is infinitely better than it was last spring and summer.

When I became horticultural commissioner of Ventura County in 1910, I visited the Allen orchard in San Diego County and saw the good work of the ladybird beetle there. Realizing that some means should be taken to augment the meager supply of beetles left in the orchards at Santa Paula, I fitted up a glass greenhouse in the Webber place, across from the Blanchard orchards, and tried to rear them in confinement. Some progress was made, but

[89] *Mealy bug and fumigation*, Bul. Claremont Pomological Club, p. 10, 2 figs. (Jan. 18, 1909). Introduced the following spring and summer.
[90] *Ibid.*, p. 12 (Jan. 18, 1909).

the difficulty of supplying food prevented the rearing of sufficient numbers to make the experiment successful.

Cryptolæmus montrousieri Muls. became a commercial factor in the control of mealybugs in 1916, after Smith and Branigan,[91] of the State Insectary, discovered that mealybugs could be successfully reared in confinement on potato sprouts. This made mass production and liberation of the ladybird beetle possible and great strides in this phase of the biological method of controlling mealybugs immediately followed. In this work, H. S. Smith and H. M. Armitage of the State Insectary ably showed the way and made possible the creation of a large number of county and association insectaries for the express purpose of rearing the mealybug destroyer.[92] It was soon discovered that the regular mass production and liberation of this predacious beetle in great numbers afforded reliable control of the various species of mealybugs in the citrus orchards of southern California. From an experiment, insectary work became a regular organized factor in the production of citrus fruits and the propagation of the ladybird beetles has gradually increased until last year approximately forty millions were actually liberated in the citrus orchards of the state! Mass production began in 1918 [93] and continues to the present time. As an example of production possible attention is called to the liberations of the State Insectary during the experimental period, 1917–1923:[94]

1917–1918,	8,155	adults
1918–1919,	103,839	"
1919–1920,	156,885	"
1920–1921,	150,645	"
1921–1922,	81,335	"
1922–1923,[95]	141,825	"
Total	642,684	"

[91] Branigan, E. J., *A satisfactory method of rearing mealybugs for use in parasite work*, Calif. State Hort. Com., Mthly. Bul., vol. 5, pp. 304–306, figs. 98–99 (1916).

[92] It is well to call attention to the fact that the production of black scale and mealybugs on potato sprouts and the rearing of *Metaphycus lounsburyi* (How.) and *Cryptolæmus montrouseri* Muls., were largely responsible for the creation of modern insectaries in California.

[93] Armitage, H. M., *Controlling mealybugs by the use of their natural enemies*, Calif. State Hort. Com., Mthly. Bul., vol. 8, pp. 257–260 (1919).

Smith, H. S., and Armitage, H. M., *ibid.*, vol. 9, pp. 114–115, 191–158, figs. 44, 47–56 (1920); vol. 10, pp. 590–591, fig. 88 (1921).

Biological control of mealybugs in California, *ibid.*, vol. 9, pp. 104–158, figs. 39–67, col. pl. (1920).

[94] Smith, H. S., Calif. State Dept. Agr., *Mthly. Bul.*, vol. 12, pp. 340–341 (1923).

[95] In the year 1922–1923 the State Insectary at Whittier handled two millions

Some of the other insectaries produced even more.

In 1926 there were twelve commercial insectaries in southern California, which reared and liberated 8,952,619 adult mealybug destroyers. The investment in these insectaries amounted to $150,000 and the cost of rearing and liberating the beneficial beetles was $100,000. The citrus acreage involved was 47,800 acres.[96]

During the fiscal year from July 1, 1926, to June 30, 1927, the insectaries belonging to Los Angeles County reared and distributed 4,000,000 mealybug destroyers to control the citrophilus mealybug in that county,[97] and 42,131,331 beetles is the estimated output of all the insectaries of the state for that year. These were reared and distributed as follows:

Los Angeles County	
Los Angeles County Insectaries, Riviera and Downey	7,165,720
San Gabriel Valley Pest Control Association, Lamanda Park	2,162,935
Orange County	
Bastanchury Ranch, Fullerton	200,000
C. C. Chapman Ranch, Fullerton	250,000
Orange County Insectary, Anaheim	20,876,460
Riverside County	
Riverside County Insectary, Riverside	384,000
San Bernardino County	
San Bernardino County Insectary, Upland	No record
San Diego County	
San Diego County Insectary, Chula Vista	168,776
Santa Barbara County	
Santa Barbara County Insectary, Santa Barbara	1,763,040
Ventura County	
Fillmore Citrus Protective District, Fillmore	700,000
Limoneira Company, Santa Paula	3,333,540
Oxnard Citrus Association, Hueneme	2,135,000
Powers Ranch, Ventura	432,290
Santa Paula Citrus Association, Santa Paula	2,559,570
Ventura County Insectary, Santa Paula	
Total	42,131,331

The Australasia ladybird beetle, *Orcus australasiæ* (Bdv.), has an early history similar to that of the succeeding species. It was

of parasitic and predacious insects of which one-third were reared and two-thirds collected in the field.

[96] Brock, A. A., Calif. State Dept. Agr., *Mthly. Bul.*, vol. 16, p. 343 (1927).

[97] Armitage, H. M., *ibid.*, vol. 17, pp. 53–54 (1928).

COLONIZATION OF THE AUSTRALASIA LADYBIRD IN CALIFORNIA

Date of Liberation	Distributed to	Number Liberated	For	Inspected by	Date of Inspection	Results of Inspection
May 14, 1892	* Home of A. Kœbele, Alameda	5 adults	San José scale	D. W. Coquillett	Oct. 21, 1892	Two adults, two pupæ and seven larvæ
				A. Kœbele	Feb., 1893	Reported doing well by Kœbele
First half of June, 1892	† Ellwood Cooper, Santa Barbara	24 adults	Black scale on olives	D. W. Coquillett	Oct. 26, 1892	Found 54 adults 20 pupæ 3 larvæ
First half of July, 1892	"	Many "	"	"	"	
				A. Kœbele Alex. Craw	Aug. 16, 1893	Found numerous and doing well
First half of July, 1892	* A. Scott Chapman, San Gabriel	1 "	Yellow scale	D. W. Coquillett	Oct. 28, 1892	No living specimens found

* Sent to B. M. Lelong and distributed by Alex. Craw.
† Sent directly to Ellwood Cooper.

COLONIZATION OF THE AUSTRALASIA LADYBIRD IN CALIFORNIA

Date of Liberation	Distributed to	Number Liberated	For	Inspected by	Date of Inspection	Results of Inspection
Aug., 1892 (about Aug. 6)	* E. Kimball, Hayward	146 adults	In orange orchard	No definite information is given concerning this lot		
Nov. 28, 1891	Under tented tree infested with red scale	5 "	Red scale	Sent directly to Coquillett at Los Angeles		
Dec. 28, 1891	Disposition unknown	1 "		"		
Jan. 23, 1892	22 under tent; 59 on ash tree infested with black scale	45 " 36 pupæ	Red scale and Black scale	"		
Apr. 15, 1892	In orange orchard of Wm. Niles	9 adults	Red scale	"		
May 14, 1892	For breeding In orange orchard of Wm. Niles	10 " 10 "	" "	"		

* Colonized by A. Kœbele.

described as *Coccinella australasiæ* by Boisduval [98] from specimens found in the Dejean collection taken from Australia (New Holland). This spotted species has a much wider distribution in eastern Australia, extending from Tasmania into Queensland. It was collected by Kœbele [99] along with *O. chalybeus* (Bdv.) at Parramatta, New South Wales, on November 2, and December 21, 1891, where it was feeding on red scale, *Lecanium* sp. and *Eriococcus leptospermi* Maskell. It was also reported to feed upon a leafhopper and aphis. Adults were collected by Kœbele at Parramatta and shipped to California from Sydney on Nov. 2, 1891, and a colony collected at the same place on July 3, 1892, was brought to Alameda by Kœbele in person. He left Sydney July 11, 1892, and arrived home on August 5, 1892. Colonies were also brought in by H. Compere in 1927 and propagated at Riverside. They have now become established.

The colonization of this species is shown in the table on pages 310 and 311.[100]

Colonies were also collected by Geo. Compere in Tasmania and sent to California where they arrived, October 7, 1900, and were liberated by Alexander Craw.[101] This species soon perished, so never became a factor in biological control in California.

The steel-blue ladybird beetle, *Orcus chalybeus* (Bdv.), was first described from specimens in the Dejean collection by Boisduval as *Coccinella chalybea* in 1832–1835,[102] collected in Australia (New Holland). The beautiful little metallic-blue beetle was afterwards described by a number of systematists, but gained notoriety through its introduction into California and other places for the control of coccids and other homopterous insects. On October 23,

[98] Boisduval, J. A., *Voyage de l'Astrolabe* (Paris, 1832–1835), p. 593 (7).
Froggatt, W. W., *Agr. Gaz. N. S. Wales*, vol. 13, p. 904, col. pl. 13, fig. 11 (1902).

[99] Kœbele, A., *Rept. on the importation of parasites and predaceous insects*, Calif. State Bd. Hort., pp. 7–14, col. pl. 1, figs. 2–2a (1892); *Studies of parasitic and predaceous insects in New Zealand, Australia, and adjacent islands*, U. S. Dept. Agr., pp. 16–18, 25–26 (1893).

[100] *Insect Life*, vol. 5, pp. 41–43 (1892), 251–254 (1893); vol. 6, p. 27 (1893).
Rept. on the importation of parasites and predaceous insects, Calif. State Bd. Hort., 15 pp., 1 col. pl. (1892).
Calif. State Bd. Hort., *Fourth Bien. Rept.*, 1893–1894, p. 101, pl. 1, figs. 2 and 2a (1894).
Coquillett, D. W., U. S. Dept. Agr., Div. Entom., *Bul. 30*, pp. 12–15, 16–18 (1893). (Description of various stages.)

[101] Calif. State Bd. Hort., *Seventh Bien. Rept.*, 1899–1900, p. 68 (1901).

[102] Boisduval, J. A., *Voyage d l'Astrolabe* (Paris, 1832–1835), p. 595 (11).
Froggatt, W. W., *Agr. Gaz. N. S. Wales*, vol. 13, p. 903, col. pl. 13, fig. 10 (1902).

1891, Kœbele [103] found this ladybird feeding upon the red scale at Parramatta, New South Wales, Australia, and forwarded some three thousand specimens along with *Orcus australasiæ* (Bdv.) to California, which left Sydney, November 2, 1891. They arrived in Los Angeles in January, 1892. Kœbele encountered the beetle in large numbers from Sydney to Brisbane where it occurred on plants infested with red scale, *Eriococcus* sp., *Chionaspis* sp. and other coccids. He evidently sent over a number of lots which later arrived in California in February, April, May, and July. The last of these lots was taken in hibernation in New South Wales on July 3, 1892, and brought over by Kœbele upon his leaving Australia, July 11, 1892. He arrived with them at San Francisco on August 5, 1892.

The specimens collected during this second visit to Australia by Kœbele were distributed in California [104] by a number of persons. The colonization and subsequent inspections are shown in the partial list on pages 314 and 315.

Since the original introductions the steel-blue ladybird beetle was colonized along the coast in Santa Barbara, Ventura, Los Angeles, Orange, and San Diego counties. For some years it persisted in several of these counties, but in the end it disappeared excepting at Goleta and at Carpinteria in Santa Barbara County. In 1911 I collected several hundred adults at Carpinteria where they occurred on citrus trees infested with black scale, red scale, and purple scale. I liberated these on citrus trees at Santa Paula slightly infested with red scale and black scale, at Ventura on trees well infested with purple scale and black scale, and at Hueneme,[105] on the Thomas Bard estate of ornamental plants infested with various scale insects. During the following winter the beetle disappeared in all of these localities. It has since been recolonized in most of the coastal counties, in some many times, but without greatly increasing the range of the species.

[103] Kœbele, A., *Rept. on the importation of parasites and predaceous insects*, Calif. State Bd. Hort., pp. 7–14, col. pl. 1, figs. 1–1b (1892); *Studies of parasitic and predaceous insects in New Zealand, Australia, and adjacent islands*, U. S. Dept. Agr., pp. 16–18, 24–25 (1893).

Coquillett, D. W., U. S. Dept. Agr., Div. Entom., *Bul. 30*, pp. 12–15, 19–20 (1893). (Description of different stages.)

[104] *Insect Life*, vol. 5, pp. 41–43 (1892), 251–254 (1893); vol. 6, pp. 24–27 (1893). *Rept. on the importation of parasites and predaceous insects*, Calif. State Bd. Hort., 15 pp., 1 col. pl. (1892).

Calif. State Bd. Hort., *Fourth Bien. Rept.*, 1893–1894, pp. 101–102, pl. 1, fig. 1 (1894).

[105] Essig, E. O., Ventura County Hort. Commr., *Bul. no. 2* (1911).

COLONIZATION OF THE STEEL-BLUE LADYBIRD IN CALIFORNIA

Date of Liberation	Distributed to	Number Liberated	For	Inspected by	Date of Inspection	Results of Inspection
January, 1892	* A. F. Kercheval, Los Angeles	325 adults	Red scale on citrus	D. W. Coquillett	Aug., 1893	Between 1200 and 1500, principally adults present
February, "	"	8 "	"	"	"	
April, "	"	27 "	"	"	"	
Last half of February, 1892	† H. K. Snow, Tustin	50 "	"	"	Oct. 29, 1892 Aug., 1893	No living specimens found
Last half of February, 1892	† S. W. Preble, Tustin	30 "	Various scales on orange trees	"	Oct. 29, 1892 Aug., 1892	No living specimens found
May 14, 1892	† Home of Albert Kœbele, Alameda	40 "	San José scale	"	Oct. 21, 1892	No living specimens found
Middle of May and Aug., 1892	† E. Kimball, Hayward	Several "	In orange orchard	"	"	No living specimens found

* Distributed by D. W. Coquillett, who received them from Kœbele.
Coquillet received the following specimens directly from Kœbele.
Nov. 28, 1891—4 adults, liberated under tented orange tree infested with red scale.
Dec. 28, 1891—3 adults.
Jan. 23, 1892—400 adults, 75 liberated under tented tree and remaining 325 liberated in an orange orchard infested with red scale (Wm. Niles orchard).
Feb. 20, 1892—8 adults, liberated in Niles orchard.
Mar. 21, 1892—Lot all dead.
Apr. 15, 1892—27 adults liberated in Niles orchard.
May 14, 1892—560 adults; 20 retained for breeding experiments, remainder liberated in Niles orchard.
† Sent to B. M. Lelong, and liberated by Alex. Craw.

COLONIZATION OF THE STEEL-BLUE LADYBIRD IN CALIFORNIA

Date of Liberation	Distributed to	Number Liberated	For	Inspected by	Date of Inspection	Results of Inspection
Middle of May, 1892	† A. Block, Santa Clara	Colony adults	San José scale	D. W. Coquillett	Oct. 22, 1892	No living specimens found
Middle of May, 1892	† J. R. Dobbins, San Gabriel	12 "	Yellow scale	"	Oct. 28, 1892 Aug. 1, 1893	No living specimens found
May 14, 1892	* Wm. Niles, Los Angeles	540 "	Citrus scales	"	Aug., 1893	Less than 100 adults found
First half of July, 1892	† A. Scott Chapman, San Gabriel	150 "	Yellow scale	"	Oct. 28, 1892 Aug., 1893	No living specimens found
Feb., 1892 First half of July, 1892	† H. Hamilton "	6 " 70 "	Red scale "	" "	Oct. 29, 1892 Aug., 1893	Died in jar. No living specimens found
First half of July, 1892	‡ Ellwood Cooper, Santa Barbara	400 adults mostly *O. chalybeus* and some *O. australasiæ*	Black scale on olive trees	" A. Kœbele and A. Craw	Oct. 26, 1892	Found 30 adults and 8 pupæ. No living specimens found

* Distributed by D. W. Coquillett, who received them from Kœbele.
Coquillet received the following specimens directly from Kœbele:
Nov. 28, 1891—4 adults, liberated under tented orange tree infested with red scale.
Dec. 28, 1891—3 adults.
Jan. 23, 1892—400 adults, 75 liberated under tented tree and remaining 325 liberated in an orange orchard infested with red scale (Wm. Niles orchard).
Feb. 20, 1892—8 adults, liberated in Niles orchard.
Mar. 21, 1892—Lot all dead.
Apr. 15, 1892—27 adults liberated in Niles orchard.
May 14, 1892—560 adults; 20 retained for breeding experiments, remainder liberated in Niles orchard.
† Sent to B. M. Lelong, and liberated by Alex. Craw.
‡ Sent directly to Cooper by Kœbele.

For several years the State Insectary collected and liberated colonies of this beetle in various parts of southern California, as follows:[106]

1919–1920	200	adults
1920–1921	6,375	"
1921–1922	65,365	"
1922–1923	4,150	"
Total	76,090	"

In 1922 Armitage[107] notes that "while it carried through a rather severe winter in considerable numbers it has not shown any inclination to increase to any extent except in one of the plots in Orange County. In this plot on the Hewes' Ranch at Orange they have maintained themselves through several generations in fair numbers. In the other plots they have completely disappeared." According to A. C. Davis, the species has also maintained itself in considerable numbers at Costa Mesa near Newport in the same county.

Orcus bilunulatus (Boisduval) (*Coccinella bilunulata*) was collected in considerable numbers by Kœbele in various parts of eastern Australia on his second trip in 1892.[108] It was feeding on *Eriococcus conspersus* Mask., a coccid infesting *Casuarina*, but it also feeds on *Eriococcus turgipes* Mask., and *Lepidosaphes gloveri* (Pack.). Coquillett reports that the receipt of only one lot consisting of thirty adults which reached him on February 20, 1892, and which was liberated on a tented orange tree infested with black scale at Judge Silent's.[109] As no other reference is made to the insect it must have shortly perished.

DIPTERA (Order)

Flies

SARCOPHAGIDÆ (Family). Flesh Flies.

Opsophyto opifera (Coq.) [*Sarcophaga, Locustivora pachytyli* (Skuse), *Masicera pachytyli* Skuse,] [110] is an important parasite of

[106] Smith, H. S., Calif. State Dept. Agr., *Mthly. Bul.*, vol. 12, p. 341 (1923).
[107] Armitage, H. M., Calif. State Dept. Agr., *Mthly. Bul.*, vol. 11, p. 828 (1922).
[108] Kœbele, A., *Studies of parasitic and predaceous insects, etc.*, U. S. Dept. Agr., pp. 26–27 (1893).
Froggatt, W. W., *Agr. Gaz. N. S. Wales*, vol. 13, p. 904, col. pl. 13, fig. 12 (1902).
[109] Coquillett, D. W., U. S. Dept. Agr., Div. Entom., *Bul. 30*, p. 14 (1893).
[110] Coquillett, D. W., *Insect Life*, vol. 5, p. 22 (1892).

plague locusts belonging to the genus *Chortoicetes* in Australia. George Compere found this parasite very abundant at Corowa, New South Wales, where he reported it to have killed from 60% to 70% of the grasshoppers. In April, 1900, he shipped a lot of puparia to California which were received by Craw on May 7th. From this material Craw reared 49 adult flies which were liberated in the Livermore Valley, June 11, 1900, where grasshoppers were abundant.[111] In connection with this species, J. M. Aldrich has furnished the following interesting and valuable information:[112]

I just noticed a peculiar item in my card index, which will interest you, I know.

I was working up my notes taken in the British Museum, when I happened on a card in my index headed *Masicera pachytyli* Skuse, which contained the following note,

"Essig, *Mo. Bull. Cal. Bd. Hort.*, vol. ii, p. 260, fig. (1913).—An Australian grasshopper parasite, introduced into California by Compere, not since seen. See same publication, ii, 626, where Compere claims credit for preventing epidemics of grasshoppers in Livermore Valley since 1900."

Skuse sent some specimens of his *pachytyli* to the National Museum many years ago. They are a *Sarcophaga*, or close to it. Johnson and Teigs in Australia proposed the new genus *LOCUSTIVORA* for the species. When Townsend was here last December I called his attention to this generic name, and the fact that we had the type species. He made a close examination of *pachytyli* and said to me: "It, that is the genus, is exactly synonymous with my *Opsophyto*, the species are almost identical." Now the genus *Opsophyto* has for its type (and only) species *Sarcophaga opifera* Coq., a common grasshopper parasite of California.

Perhaps it would not be safe to say that they are really the same species, but they are remarkably allied and differ only in minute characters, which are perhaps variable. We do not have enough of the Australian material to feel quite safe in asserting them to be the same. In fact, most of the Australian specimens have yellowish legs, only one of them, I believe, having black, as in the California species.

We have a long series of the California species bred from grasshoppers at Natoma, Calif., in 1885. The species is widespread, at least from Washington to Texas. It certainly is curious that two species so nearly related as to be almost identical, should be separated in nature (as far as we know) by half the width of the world.

Townsend, C. H. T., *Proc. Biol. Soc. Wash.*, vol. 28, p. 23 (1915).

Aldrich, J. M., *Sarcophaga and allies*, Thomas Say Found., Entom. Soc. Am., pp. 119–121 (1915).

Essig, E. O., *Insects Western No. Am.*, p. 586 (1926).

[111] Calif. State Bd. Hort., *Ann. Rept.*, 1891, pp. 216–218, figs. 8–11 (1892); *Seventh Ann. Rept.*, 1899–1900, pp. 15, 66–67 (1901); *Eighth Rept.*, 1901–1902, pp. 121–122, figs. 3–5 (1902).

[112] Letters dated, Washington, D. C., Sept. 30, and Oct. 16, 1929.

According to Aldrich, the material in the U. S. National Museum reveals the following facts concerning the dates, hosts, and distribution of this species:

Six specimens reared from *Melanoplus devastator* Scudd. and *M. marginatus* (Scudd.) at Natoma, Calif., 1885 (D. W. Coquillett).

Six specimens from *M. spretus* (Uhler), [113] Sacramento, Calif. (D. W. Coquillett).

Two from Pullman, Washington, Sept. 12, 1896 and Sept. 1, 1897 (R. W. Doane).

Two from Wilson Creek, Wash., June 22, 1908 (G. I. Reeves).

One from Stanford University, Calif. (J. M. Aldrich).

Three, Moscow, Idaho (J. M. Aldrich).

One, Uvalde, Texas, July 16, 1914 (F. C. Bishopp).

Four, reared from *M. differentialis* (Thomas), *M. plumbeus* (Dodge), and *M. bivittatus* (Say), Maxwell, New Mexico (C. K. Wildermuth).

Two, from grasshoppers, Brawley, Calif. (C. M. Packard).

ANTHOMYIIDÆ (Family). Root Maggots.

The lesser house fly, *Fannia canicularis* (Linn.), is a European species now introduced into many parts of the world and breeds in decaying vegetable matter and excrement of all kinds. It was early established in New Zealand and Australia and was sent by Geo. Compere from Australia to California, as a supposed parasite of grasshoppers. The first lot of 59 adults was liberated by Craw in the Livermore Valley, June 14, 1900.[114] Two other lots were received by Craw on Feb. 10, and Feb. 24, 1901, respectively. They were held in cold storage until grasshoppers appeared, when adults were liberated in the Livermore Valley as before.[115] This is a very common insect in California, and was probably introduced in ships at the time or soon after the occupation by the Spanish in 1769.

AGROMYZIDÆ (Family).

The dipterous parasite of the cottony cushion scale, *Cryptochætum iceryæ* (Williston),[116] was discovered at Adelaide, South

[113] *M. femur-rubrum* (De Geer) or *M. atlanis* (Riley), or both.

[114] Calif State Bd. Hort., *Seventh Ann. Rept.*, 1899–1900, pp. 66–67 (1901).

[115] *Ibid.*, Eighth Rept., 1901–1902, p. 197 (1902).

[116] Williston, S. W., *An Australian parasite of* Icerya purchasi, Insect Life, vol. 1, pp. 21–22, fig. 3 (1888) (Original description); pp. 328–331, figs. 72–73 (1889). *Insect Life*, vol. 1, pp. 64–65, 144, 164–165, 199–200 (1888); vol. 2, pp. 377–378 (1890); vol. 4, p. 254 (1892).

Australia, by Frazer S. Crawford in 1886, who observed it destroying the cottony cushion scale in his garden. "He sent specimens to Miss Ormerod [117] in December, 1886, and wrote to us (C. V. Riley) about it in February, 1887. Miss Ormerod forwarded some of the specimens received by her to us, but they were badly damaged, and it was not until the early summer of 1888 that we received perfect specimens fit for description, although Mr. Crawford had meantime written us several letters and had sent drawings and other specimens." [118] In July, 1888, Williston described the species as *Lestophonus iceryæ* [119] from three specimens received from Riley. The parasite was mentioned by Riley in the Pacific Rural Press (vol. 33, p. 507, June 4, 1887), which was no doubt responsible for the part taken by W. G. Klee, State inspector of fruit pests of the California State Board of Horticulture. Quite independent of Riley, who was in Europe during the summer of 1887, Klee addressed a request to Crawford for specimens. He received a reply in December, 1887, and subsequently made arrangements with the Australian Steamship Line to have the parasites cared for when sent.[120] Riley also wrote for living specimens to colonize in California. "In response to these requests Mr. Crawford very generously devoted considerable time and trouble to the matter, and was able to secure through his personal efforts a number of infested specimens of both *Icerya* and *Monophlebus*,[121] which were forwarded to Messrs. Coquillett and Klee. The specimens which came to Mr. Klee were by him turned over to our California Agent, Mr. Kœbele, and both Mr. Coquillett and Mr. Kœbele endeavored to isolate the infested Australian scales under covered orange trees infested with *Icerya*.[122] In both cases a few specimens of *Lestophonus* issued

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Klee, W. G., Calif. State Bd. Hort., *Third Bien. Rept.*, pp. 179–181 (1888).

Riley, C. V., U. S. Dept. Agr., *Rept.*, 1888, pp. 88–92, pl. 11, fig. 2 (1889).

Essig, E. O., Calif. State Hort. Com., *Inj. and Ben. Ins. Calif.*, p. 250, fig. 246 (1913); ed. 2, pp. 348–349 (1915); *Insects W. N. Am.* (N. Y., Macmillan, 1926), pp. 615–616, figs. 496–498.

Knab, F., *Insecutor Inscit. Menst.*, vol. 2, p. 33 (1914).

Smith, H. S., and Compere, H., Calif. State Hort. Com., *Mthly Bul.*, vol. 5, pp. 384–390, figs. 128–136 (1916) (Life history).

[117] Eleanor A. Ormerod, English economic entomologist (1823–1901).

[118] Riley, C. V., *op. cit.*, p. 88 (1889).

[119] Williston, S. W., *op. cit.*, pp. 21–22 (1888).

[120] Klee, W. G., *op. cit.*, pp. 178–180 (1888). The method suggested of sending the specimens on ice proved a success.—*Insect Life*, vol. 1, p. 220 (1889).

[121] Mulsant named this species *Monophlebus crawfordi* after Mr. Crawford. It was later placed in the genus *Drosicha* by Cockerell.

[122] Some of these were colonized at San Mateo in a cage on a cherry laurel badly infested with cottony cushion scale prior to October 4, 1888. No progeny of the

under cover, but so far as we have been able to learn no evidence of oviposition or propagation by these confined individuals has been observed." [123]

After much discussion Riley finally decided to send Albert Kœbele to Australia to collect and send over sufficient quantities of this parasite to definitely establish it on the cottony cushion scale in California. A clause in the appropriation bill for the Department of Agriculture prohibited the payment of traveling expenses outside of the United States, so it was necessary to seek help from other quarters. Many pages would be required to state all of the facts incident to the plan finally agreed upon, whereby, through the efforts of the Secretary of State, funds appropriated for the representation of the United States at the Melbourne Exposition, were placed at the disposal of Riley to defray the expenses of sending two men to Australia, one to collect *Lestophonus* and the other to represent the country at the exposition. Albert Kœbele was appointed to the first task and F. M. Webster to the latter. Accordingly Kœbele sailed from San Francisco on August 25, 1888,[124] and arrived at Sydney, September 20th. His first duty was to visit Crawford at Adelaide where he arrived on October 2d. He states that the next morning the very first scale he examined contained nine pupæ of the sought-for parasite. What a thrill it must have been! Concerning his experiences with the *Lestophonus* he wrote Riley:[125]

So far my work has been much more successful than I expected. I not only found the dipterous parasite within *Icerya* in large numbers, but also three predaceous larvæ feeding upon the eggs of *Icerya*. One of these is a *Chrysopa* larva, which I first discovered in numbers, it having almost destroyed all the eggs of the infested *Icerya* at Mannam, 28 miles up the Murray River from Murray Bridge Station, South Australia; the others are larvæ of a small *Coccinella*. I have collected and sent with this steamer, *Mariposa*, probably 10,000 Iceryæ, of which at least 50 per cent are infested with the dipterous larvæ and pupæ. Dr. Schomburg, director of the Botanical Gardens of Adelaide, kindly furnished me with a wardian-case, in which I placed three young orange trees and nine of Pittosporum, securely packed down. The Iceryæ were placed in this on sticks of orange placed in earth, so the smaller, half grown insects can easily crawl up on the fresh plants, and the flies that hatch

fly was discovered on November 11, 1888. *Insect Life*, vol. 1, pp. 144 (1888), 220 (1889).

[123] Riley, C. V., *op. cit.*, p. 89 (1889).

[124] This date has been erroneously given as August 20th and August 23d.

[125] *Insect Life*, vol. 1, p. 165 (1888); U. S. Dept. Agr., Div. Entom., *Bul. 21*, pp. 11–30 (1890).

en route may be able to go on breeding. Besides these, I send a large lot in tin and wooden boxes, chiefly taken off of twigs; these latter I have placed in the ice-box, so that none will be able to hatch during the voyage. As it looks now, for all are on steamer already, the latter experiment will be the best to follow. Notwithstanding the care and labor I have spent in getting this case here in such condition, I fear that the packages will suffer greatly through the handling of the steamer hands. However, it may be, I assure you that success will attend your effort, and I expect to land several thousand of flies in pupa state with every steamer landing at San Francisco.

In regard to the case with plants, this is a bulky thing, weighing 240 pounds, while the same number of scales packed in boxes would make only a few pounds.

The most difficult matter is to get Iceryæ in such large numbers. As yet I have found them only in private gardens, but I know of sufficient for another sending.

On coming on here I also discovered the flies within Iceryæ in Victoria, and am certain that they will be found all over Australia, or wherever *Icerya* is present.

They are not only parasitic upon *Monophlebus* and *Icerya*, but I am almost certain also upon *Dactylopius*. I found many empty puparia within dried-up *Dactylopius*, and also have several fresh ones at Adelaide.

Will remain in New South Wales for about a week or so and make a careful examination of the ground, then proceed to Victoria in search of *Icerya*, but will be in Adelaide in time to make up a larger shipment.

This shipment of parasites left Sydney in October and was received in December, 1888 by Coquillett, [126] who liberated them in a tent over a tree infested with the scale. This was undoubtedly the first successful introduction of the parasite into southern California. Another lot of *Cryptochætum* was sent just before Kœbele left Australia in February,[127] which was also successfully colonized in southern California by Coquillett. In all Kœbele is credited with sending 12,000 specimens of *Cryptochætum* to California during this period. On April 12, 1889, Kœbele examined the tent under which Coquillett had liberated the *Cryptochætum* and found that some had already issued from the cottony cushion scale. A secondary parasite on *Cryptochætum* was discovered in Australia by Kœbele, who cautioned Coquillett to prevent its establishment in California [128] and due to the carefulness of the latter this was avoided. Riley described it as *Euryischia lestophoni* in 1889.[129]

[126] *Insect Life*, vol. 1, pp. 199–200 (1888).
[127] *Ibid.*, vol. 1, p. 297 (1889).
[128] *Ibid.*, vol. 2, pp. 377–378 (1890).
[129] *Rept. U. S. Dept. Agr.*, *1888*, p. 92, pl. 9, fig. 2 (1889).

In northern California this parasite continued, to the present time, to be the most efficient enemy of the cottony cushion scale. Wherever the vedalia is liberated, it destroys all of the scale and soon disappears, while the *Cryptochætum* is as persistent as its host. In the southern part of the state, while the vedalia is the more important, yet the dipterous parasite is often present in great numbers and plays a more important rôle in the subjugation of the scale than is usually credited it. (Also see discussion under Albert Kœbele.)

LEPIDOPTERA (Order)

Butterflies and Moths

NOCTUIDÆ (Family). Armyworms and Cutworms.

Australian coccid-eating moth, *Eublemma cocciphaga* (Meyrick) (*Thalpochares cocciphaga* Mey.).[130] This interesting and important coccid-feeding moth has captivated all of the California collectors who have noted its work in Australia. Kœbele observed its effective work on black scale in New South Wales on his first trip in 1889 and specimens were successfully sent to California and liberated near Los Angeles by Coquillett. In 1892 considerable numbers of the larvæ of this moth were again sent to California by Kœbele and about a dozen adults were liberated in Hayward by B. M. Lelong on a lemon tree infested with black scale and covered with a light cloth tent. This tent was removed about October 1st. A sending of larvæ and pupæ direct to Ellwood Cooper at Santa Barbara was liberated in his olive orchard which was infested with black scale. An examination of all the places where this insect was previously liberated in October, 1892, and still another in 1893, failed to disclose any of the stages of the moth. It had completely disappeared.

E. J. Vosler found this moth to be one of the most important natural enemies of the black scale when he visited New South Wales in 1918. In fact it so impressed him that he collected a lot and forwarded it to the state insectary at Sacramento. In captivity eggs were procured, July 16, 1918, the first larvæ emerged

[130] Kœbele, A., U. S. Dept. Agr., Div. Entom., *Bul. 21*, p. 22, fig. 11 (1890); *Rept. on the importation of parasites and predaceous insects*, Calif. State Bd. Hort., p. 9, col. pl. 1, figs. 6, 6a (1892); *Studies of parasitic and predaceous insects in New Zealand, Australia, and adjacent islands*, U. S. Dept. Agr., pp. 13, 18, 36–37 (1893).
Insect Life, vol. 5, pp. 55–56 (1892); pp. 252, 253–254 (1893); vol. 6, p. 29 (1893).
Craw, A., Calif. State Bd. Hort., *Rept., 1893–4*, pp. 103–104 (1894).
Vosler, E. J., Calif. State Hort. Com., *Mthly. Bul.*, vol. 8, pp. 238–239, figs. 100–103 (1919).

July 24 and the first adults of the new generation appeared September 9, 1918. The colonization of these adults on black scale in California again gave negative results.

Erastria scitula Rambur [131] feeds on black scale in southern Europe. Riley attempted to introduce this moth into the United States in 1892 but failed. In 1901 A. Berlese sent living pupæ to Howard who in turn sent them to Craw and Ehrhorn in California. The adults reared from these were liberated on black-scale-infested plants in Alameda, Los Angeles, and Santa Clara counties, but no further account has ever been made of the insect.

PYRALIDÆ (Family). Pyralid Moths.

The coccid moth, *Lætilia coccidivora* Comstock,[132] is an American species occurring in the eastern and southern states west to New Mexico and Arizona. Specimens were received in California from G. F. Moznette, Bureau of Entomology, Miami, Florida, on June 12, 1922. These were procured by H. S. Smith and reared at Whittier. From the lot 28 adults were recovered and were liberated on black scale at Whittier.[133]

PARASITIC HYMENOPTERA [134] (Group).

BRACONIDÆ (Family). Braconid Flies.

Apanteles glomeratus (Linn.) is a European insect parasitic chiefly on the cabbage butterfly, but it also attacks related butter-

[131] Calif. State Bd. Hort., *Eighth Ann. Rept.*, 1901–1902, p. 200 (1902).

Howard, L. O., and Fiske, W. F., U. S. Dept. Agr., Bur. Entom., *Bul. 91*, p. 34 (1911).

[132] Comstock, J. H., *No. Am. Entom.*, vol. 1, p. 25, pl. 4 (1879); U. S. Dept. Agr., *Rept., 1880*, p. 241 (1881).

Packard, A. S., *Ins. inj. to shade trees*, p. 54 (1881).

Hulst, G. D., *Trans. Am. Entom. Soc.*, vol. 17, p. 182 (1890).

[133] Smith, H. S., Calif. State Dept. Agr., *Mthly. Bul.*, vol. 11, p. 829 (1922).

[134] Kœbele, A., *Report of a trip to Australia to investigate the natural enemies of the fluted scale*, U. S. Dept. Agr., Div. Entom., Bul. 21, 32 pp., 16 figs. (1890).

Report on the importation of parasites and predaceous insects, Calif. State Bd. Hort., pp. 1–12 (1892).

Studies of parasitic and predaceous insects in New Zealand, Australia, and adjacent islands, U. S. Dept. Agr., 39 pp. (1893).

Craw, Alex., *Report on the importation of parasites and predaceous insects*, Calif. State Bd. Hort., pp. 13–15 (1892).

Coquillett, D. W., *Report on the Australian insects sent by Albert Kœbele to Ellwood Cooper and B. M. Lelong*, Insect Life, vol. 5, pp. 251–254 (1893).

Howard, L. O., *The hymenopterous parasites of the California red scale*, Insect Life, vol. 6, pp. 227–236, figs. 6–11 (1894).

Isaac, John, *Bug vs. bug*, Calif. State Bd. Hort., Rept. 1903–1904, pp. 79–107, 16 figs., 4 col. pls. (1904) (issued separately, 1906).

flies and some moths. It was introduced into the United States from England in 1883. Through the help of F. H. Chittenden it was

Essig, E. O., *Natural enemies of the citrus mealybug*, P. C. Jour. Entom., vol. 1, pp. 143–146, figs. 57–59 (1909); vol. 2, pp. 260–274, figs. 106–108 (1910); vol. 3, pp. 390–397, figs. 134–137, pp. 518–522, figs. 166–168 (1911).

Injurious and beneficial insects of California, pp. 268–279, figs. 266–281 (1913); ed. 2, pp. 361–378, figs. 364–379 (1915).

Insects of Western North America (N. Y., Macmillan, 1926), pp. 779–800, 813–853, figs. 655–667, 685–720.

Quayle, H. J., *Scale parasitism in California*, Jour. Econ. Entom., vol. 4, pp. 510–515 (1911).

Smith, H. S., *Mealybug parasites in the Far East*, Calif. State Hort. Com., Mthly. Bul., vol. 3, pp. 26–29 (1914).

Insect parasites and predators as adjuncts in the control of mealybugs, *ibid.*, vol. 6, pp. 108–114, figs. 31–40 (1917).

Biological control of the black scale in California, *ibid.*, vol. 10, pp. 127–137, figs. 19–25; pp. 587–590, figs. 86–87 (1921); vol. 12, pp. 334–336 (1923).

Vosler, E. J., *Some work of the Insectary Division in connection with the attempted introduction of natural enemies of the beet leafhopper*, *ibid.*, vol. 8, pp. 231–239, figs. 96–104 (1919).

Timberlake, P. H., *Preliminary report on the parasites of* Coccus hesperidum *in California*, Jour. Econ. Entom., vol. 6, pp. 293–303 (1913).

New genera and species of Encyrtinæ from California parasitic in mealybugs, Univ. Calif. Pub. Entom., vol. 1, pp. 347–367 (1918).

Timberlake, P. H., and Clausen, C. P., *The parasites of* Pseudococcus maritimus *(Ehrhorn) in California*, Univ. Calif. Pub. Entom., vol. 3, pp. 223–292, 8 figs., pls. 18–19 (1924).

Hartung, W. J., and Severin, H. H. P., *Natural enemies of the beet leafhopper in California*, Calif. State Hort. Com., Mthly. Bul., vol. 4, pp. 277–279 (1915).

Severin, H. H. P., *Natural enemies of the beet leafhopper* (Eutettix tenellus *Baker*), Jour. Econ. Entom., vol. 17, pp. 369–377 (1924).

Smith, H. S., and Armitage, H. M., *Biological control of mealybugs in California*, Calif. State Dept. Agr., Mthly. Bul., vol. 9, pp. 104–158, figs. 39–67, 1 col. pl. (1920).

Smith, H. S., and Compere, H., *The establishment in California of* Coccophagus modestus *Silv.* (*Aphelinidæ*), Univ. of Calif. Pub. Entom., vol. 4, pp. 51–61, 2 figs. (1926).

Notes on the life history of two oriental chalcidoid parasites of Chrysomphalus, *ibid.*, vol. 4, pp. 63–73, 13 figs. (1927).

A preliminary report on the insect parasites of the black scale, Saissetia oleæ (*Bernard*), *ibid.*, vol. 4, pp. 231–234, 63 figs. (1928).

The introduction of new insect enemies of the citrophilus mealybug from Australia, Jour. Econ. Entom., vol. 21, pp. 664–669 (1928).

Compere, H., *New chalcidoid parasites and hyperparasites of the black scale*, Saissetia oleæ (*Bernard*), Univ. Calif. Pub. Entom., vol. 3, pp. 295–326, pls. 20–26 (1925).

Descriptions of new coccid-inhabiting chalcidoid parasites, *ibid.*, vol. 4, pp. 1–31, 10 figs. (1926).

New coccid-inhabiting parasites (*Encyrtidæ*) *from Japan and California*, *ibid.*, vol. 4, pp. 33–50, 9 figs. (1926).

New coccid-inhabiting chalcidoid parasites from Africa and California, *ibid.*, vol. 4, pp. 209–230, pls. 6–8 (1928).

Description of a new species of Coccophagus *recently introduced into California*, *ibid.*, vol. 5, pp. 1–3, 2 figs. (1929).

Also see bibliography under Biological Control, p. 274.

The author is indebted to H. S. Smith, P. H. Timberlake, and H. Compere for reading and for making many corrections and additions to this portion on Parasitic Hymenoptera.

introduced into California by H. S. Smith in June, 1915.[135] Liberations were made at Sacramento. It has since been recovered in two places in California. In 1929 H. Compere reared adults from the cabbage butterfly in southern California. Of course it cannot be ascertained if these records are the results of the aforesaid introductions.

ICHNEUMONIDÆ (Family). Ichneumonid Flies.

The codling moth parasite, *Calliephialtes messor* (Gravenhorst),[136] was collected in Spain by George Compere from September 1, 1904, to January 1, 1905. It was forwarded to California in considerable numbers and was very successfully reared in the State Insectary at Sacramento by E. K. Carnes. Colonies were liberated in the various apple and pear districts of the state where the codling moth was prevalent. In the Pajaro Valley the insect became established in small numbers. Specimens were reared in confinement for many years and in 1907 some were sent to C. P. Lounsbury in South Africa. I saw living specimens in the State Insectary in November, 1911, and during this year also Cushman obtained two lots of parasitized codling moth larvæ from the same place. Smith and Vosler were still able to obtain living material for their study of the insect in 1914. While repeatedly liberated in very small numbers in the Pajaro Valley, the insect apparently never became permanently established in the apple orchards. Although capable of remarkable reproduction in confinement, it was unable to cope with orchard conditions in California.

TRICHOGRAMMATIDÆ (Family). Trichogrammatid Parasites.

The egg parasite, *Trichogramma minutum* Riley, was described as early as 1870,[137] but did not come into prominence in biological control until many years afterwards. In fact it was not artificially

[135] Calif. State Hort. Com., *Mthly. Bul.*, vol. 4, pp. 446, 543 (1915).

[136] Cooper, Ellwood, Calif. State Hort. Com., *2d Bien. Rept.*, 1905–1906, pp. 231–235, col. pl. (1907).

Ehrhorn, E. M., *ibid.*, Proc. 33d Fruit Growers' Conv., p. 153 (1908).

Cushman, R. A., *The* Calliephialtes *parasite of the codling moth*, Jour. Agr. Research, vol. 1, pp. 211–238, 15 figs., pl. 20 (1913).

Smith, H. S., and Vosler, E. J., Calliephialtes *in California*, Calif. State Hort. Com., Mthly. Bul., vol. 3, pp. 195–211, figs. 57–71 (1914).

Essig, E. O., *Insects of W. No. Am.*, p. 796, fig. 665.

[137] Riley, C. V., *Third Rept. Insects of Missouri*, p. 158, fig. 72 (1870).

propagated in numbers until 1926 when Stanley E. Flanders, then Entomologist, Saticoy Walnut Growers' Association, Saticoy, California, began rearing it on the eggs (Fig. 110) of the Angoumois grain moth, *Sitotroga cerealella* (Olivier), for the purpose of liberating the adults in the walnut orchards with the hope of controlling the codling moth, which had become a pest of walnuts in Ventura County.[138] His methods of propagation were so successful that I called attention to it at the annual meeting of the American Association of Economic Entomologists at Philadelphia in December, 1926. The interest in the new idea spread rapidly and *Trichogramma* has been used extensively since then in an attempt to control various lepidopterous insect pests.[139] Flanders further perfected his methods of mass production during 1927 so that during the month of July he maintained a daily production of 200,000 adults,[140] which were liberated in the walnut orchards. Thus he was able to raise the percentage of parasitism of the codling moth on few trees in the walnut orchards from 1% to 50% in three weeks. Concerning his work Flanders very kindly furnished the following notes: "At Saticoy the increase in parasitism from less than 1 per cent to 50 per cent occurred in a period of three weeks and was noted only on several trees which were carefully examined at regular intervals. The increase results directly from the liberated parasites rather than from their offspring. The fact that the host egg turns black after the parasite has finished feeding enables a check to be made on the percentage of parasitism. This type of control on fruit trees is analogous to spraying and dusting in that a greater amount of lethal material is used than is actually effective, that repetition may be necessary, and that the effect is more or less immediate. This might be called the Inundative method. On sugar cane and truck crops the Accretive method is employed. This

[138] On August 11, 1926, Flanders began using the eggs of the Mediterranean flour moth, *Ephestia kuehniella* Zeller, *Illice nexa* Bdv., and the potato tuber moth, *Phthorimæa operculella* (Zeller). The fifth generation of parasites was started on the eggs of the Angoumois grain moth, which was found to be the most suitable for rearing this parasite.

[139] Flanders, S. E., *Biological control of the codling moth*, Jour. Econ. Entom., vol. 20, p. 644 (1927).

Production and distribution of Trichogramma, *ibid.*, vol. 22, p. 245 (1929).

Hinds, W. E., and Spencer, H., *Utilization of* Trichogramma minutum *for control of the sugar cane borer*, Jour. Econ. Entom., vol. 21, pp. 273–278, pl. 5 (1928).

Wishart, Geo., *Large scale production of the egg parasite*, Trichogramma minutum Riley, Can. Entom., vol. 61, pp. 73–76, 4 figs. (1929).

[140] Flanders, S. E., *Developments in* Trichogramma *production*, Jour. Econ. Entom., vol. 21, p. 512 (1928).

depends for results upon the building up of the parasite population in the field and is, in effect, the accelerating of the natural increase.

"Common white corn is the most satisfactory for moth production. In 1929 we found that given plenty of moth eggs an infestation can be built up in eight weeks to a level at which egg production

FIG. 110.—Eggs of the Angoumois grain moth, *Sitotroga cerealella* (Olivier), used for the artificial propagation of the minute hymenopterous egg-parasite, *Trichogramma minutum* Riley. (Specimens furnished by S. E. Flanders, 1927.)

is sufficient for economical parasite propagation, i.e., one hundred thousand eggs daily per ton of corn used. This rate of production can then be maintained for about four weeks. The corn is then discarded and resold for about four-fifths of its purchase price. A rapid turn-over should decrease the mite hazard to zero. A total of three million parasites can be efficiently produced per ton of corn. A production of one hundred million in a season would require thirty tons of corn.

"On October 1, 1928, I secured 3 female parasites from codling moth eggs in the Lloyd-Butler orchard at Saticoy. At the end of seven weeks the progeny of these, composing the sixth generation, amounted to about three hundred thousand. The supply of moth eggs then became inadequate to maintain such multiplication.

"Under normal conditions the Angoumois grain moth oviposits only in crevices. The pressure from a strong current of air directed against the 20-mesh screen can be substituted. The ovipositor is thrust through the mesh of the screen against the air current. The pressure of air elicits the same response as the pressure against the sides of the crevice by an inserted ovipositor. Egg deposition is thus obtained by a forced draft."

At the Fourth International Congress of Entomology, held at Ithaca, New York, August 12–18, 1928, he gave a complete report [141] relative to his work. Concerning the adaptability of this parasite for biological control he has listed the following biotic responses:

1. It mates and oviposits readily in confinement.
2. It develops to maturity in the eggs of grain moths, one individual per host egg.
3. It has a shorter life cycle than any of its hosts; under outdoor conditions less than one-third that of the codling moth.
4. It has a more extended developmental range than its hosts; the threshold of development is about ten degrees lower than that of the codling moth.
5. It has a great variety of hosts and according to A. Hase, no host preference.
6. It accommodates itself as to number of generations according to the host it parasitizes as ascertained by P. Marchal.
7. It develops throughout the year, temperature and food permitting.
8. It has few competing species and no known secondary parasites.
9. Its dispersal is so localized that its effectiveness is measurable.
10. Its effectiveness is determined by its abundance on the food plant of the host and by the amount of host material within its sphere of action.

The chief difficulty encountered in rearing the Angoumois grain moth, was due to the ventricose mite, *Pediculoides ventricosus* (Newport), which appeared in great numbers and attacked the eggs, pupæ, and adults of the moth, thus greatly reducing the numbers of eggs available for rearing the parasite.

Some idea of the magnitude of the work of mass production as carried on by Flanders at Saticoy may be gained from the fact that in December, 1928, seven and one-half tons of new crop Hickory King corn were used for rearing the host, the Angoumois grain moth.

In January, 1929, S. E. Flanders resigned from the position with the Saticoy Walnut Growers' Association and his place was

[141] *Trans. Fourth Inter. Cong. Entom.*, vol. 2, pp. 110–130, figs. 1–13 (1929).

filled by R. E. Barrett, who has now discontinued the production of *Trichogramma minutum* Riley.

The uses of this parasite are various. It is apparently indigenous to most of this country and was reared from codling moth eggs on apple in California by Albert Kœbele as early as 1889. If the experiment now being conducted at Saticoy proves successful, it is to be expected that similar methods may be adopted for the control of the codling moth in the apple and pear orchards of the country, as well as for many of the numerous other hosts of this omnivorous parasite. The list of hosts to date include the eggs of many insects in North America.

Pterygogramma acuminata Perkins was collected in Queensland, Australia, in 1917 and again in 1918 by E. J. Vosler. There it is a parasite of the eggs of a leafhopper which feeds on atriplex and eucalyptus. Large numbers of the parasite were sent to California both years as a possible natural enemy of the beet leafhopper. It would not oviposit in the eggs of the beet leafhopper and perished.[142]

TETRASTICHIDÆ (Family). Tetrastichid Parasites.

Ootetrastichus beatus Perkins, the very effective parasite of the eggs of the sugar cane leafhopper in Queensland and Hawaii, was sent to the California State Insectary by O. H. Swezey in 1916 as a possible parasite of the eggs of the beet leafhopper, but it failed to attack the latter.[143]

Tetrastichus injuriosus Compere [144] was "described from 50 females and 25 males reared from black scale collected at Cape Town, Union of South Africa, by E. W. Rust. In addition to the specimens preserved for museum collection, many thousands of individuals have been destroyed as they issued from the South African scale material. This hyperparasite is very often reared in large numbers from *Saissetia oleæ* (Bern.) (in South Africa). In many cases, more individuals of *Tetrastichus* issue than of all the species of primary parasites combined. Adults have been observed using their ovipositor to probe scales without oviposition. It is supposed that this species has habits similar to those of *T. blepyri* Ashm., a species commonly found working as a hyperparasite of black scale in California."[145]

[142] Vosler, E. J., Calif. State Hort. Com., *Mthly. Bul.*, vol. 8, pp. 234–237 (1919).
[143] Smith, H. S., *ibid.*, vol. 6, p. 299 (1915).
[144] Compere, H., *Univ. Calif. Pub. Entom.*, vol. 4, pp. 11–18, fig. 5, A–F (1926).
[145] *Op. cit.*, pp. 14–15.

ELASMIDÆ (Family). Elasmid Parasites.

Myiocnema comperei Ashm.[146] has been reared from black scale many times, but its exact status as to whether it is primary or secondary is still uncertain. It was originally described by Ashmead in 1900 from one male and seven female specimens reared from black scale at Brisbane, Australia, by Geo. Compere in May and July, 1900.[147] Compere sent at least one colony to California which was liberated in Alameda County but he was unable to return to the place where he formally collected it to send more. It was not until late in the year 1921 that specimens of this parasite finally reached the state insectary at Whittier, California. These were collected at Sydney, N. S. W., by E. W. Rust. It was propagated in the insectary and an attempt made to study its complete life history, but as a second generation was not obtained its exact habits are still unknown. Because of this it was never liberated in the orchards of the state.

EUPELMIDÆ (Family). Eupelmid Parasites.

Lecanobius cockerelli Ashm.[148] (*Zalophothrix mirum* Crawford). This interesting little insect is predacious on the eggs of the black scale, but may become accidentally secondary or even tertiary if proper conditions prevail. It was originally described by Ashmead from specimens reared from the soft scale, *Lecanium fraternum* Ckll., taken at Antigua, British West Indies. Crawford described it as *Zalophothrix mirum* in 1908, which was recognized as a

[146] Ashmead, W. H., *Can. Entom.*, vol. 32, p. 349 (1900).

Craw, Alex., Calif. State Bd. Hort., *Seventh Bien. Rept.*, 1899–1900, p. 71 (1901); *Eighth Bien. Rept.*, 1901–1902, p. 196 (1902).

Despeissis, A., and Compere, Geo., West Australia Dept. Agr., *Bul. 4*, p. 92 (1903).

Silvestri, F., *Hawaiian Forestry and Agr.*, vol. 6, p. 306 (1909).

Berlese, A., *Inst. Internaz. d'Agricoltura*, Ann. 7, no. 3, p. 7 (1916).

Girault, A. A., *Mem. Queensland Mus.*, vol. 5, p. 211 (1916).

Smith, H. S., and Compere, H., *Univ. Calif. Pub. Entom.*, vol. 4, pp. 301–306, figs. 39–42 (1928).

[147] According to Howard, Albert Kœbele reared this species from *Kermes acaciæ* Mask., at Sydney, N. S. W., in 1899—*Entom. News*, vol. 30, p. 257 (1919).

[148] Ashmead, W. H., *Proc. Entom. Soc. Wash.*, vol. 4, pp. 8–17 (1896).

Crawford, J. C., *ibid.*, vol. 9, p. 156 (1908); *Proc. U. S. Nat. Mus.*, vol. 41, p. 275 (1911).

Ballou, H. A., *Ins. pests of the Lesser Antilles*, Imp. Dept. Agr. West Indies, Pamp. ser. no. 71, pp. 56–57 (1912).

Smith, H. S., Calif. State Hort. Com., *Mthly. Bul.*, vol. 2, p. 662 (1913); vol. 4, p. 543 (1915); vol. 11, pp. 829, 830 (1922); vol. 12, pp. 337–338 (1923).

Gahan, A. B., *Proc. U. S. Nat. Mus.*, vol. 65, art. 4, pp. 3–4 (1924).

Smith, H. S., and Compere, H., *Univ. Calif. Pub. Entom.*, vol. 4, pp. 297–301, figs. 35–38 (1928).

synonym of the former by Crawford in 1911. It is essentially a tropical and subtropical species established in the West Indies and in Florida. Specimens were sent to California from the British West Indies by Ballou in 1913 but it was not established then. G. F. Moznette, Bureau of Entomology, sent a colony of 32 adults to California which was received June 12, 1922. Some of these were liberated immediately and after rearings were made in the insectary others were liberated as follows: October 17, 1922, 13 adults on pepper trees infested with black scale at Arcadia; Oct. 18, 1922, 10 adults on lemon trees infested with black scale in orchard of C. A. Bliss, Costa Mesa, Orange County; Dec. 7, 1922, 34 adults on pepper tree infested with black scale at Inglewood Cemetery, Los Angeles County; Dec. 9, 1922, 10 adults on ornamentals infested with black scale at Santa Monica. The insectary stock gradually diminished until it was lost and as no field recoveries have been made, it is presumed that the species perished.

PTEROMALIDÆ (Family). Ptermolaid Parasites.

Pteromalus puparum (Linn.) (Fig. 111) is a widely distributed and important parasite of the cabbage butterfly, *Pieris rapæ* (Linn.). It appears to have been first noted in print by Jean Gœdart [149] in 1662 and afterwards discussed by M. S. Merian, R. A. F. de Réaumur, A. J. Rœsel, and C. DeGeer, before it was authentically described and named by Linnæus [150] in 1758. Packard [151] seems to be the first entomologist to describe the insect in this country and according to Riley,[152] he believed it to be indigenous to America and reports it having been first taken in the Hudson Bay territory in 1844. The insect was first observed on cabbage leaves in North America at Montreal, Canada, in July, 1870, by A. G. T. Ritchie who reared adults from cabbage butterfly caterpillars in August of that year. In order to be sure of the identity of the American insect, Riley received specimens from J. O. Westwood of England and G. L. Mayr of Austria and found them to be identical.

Thomas [153] also referred to the insect in Illinois in 1883.

The insect either occurs naturally or has spread over the entire

[149] *Metamorphosis et Historia Naturalis Insectorum*, vol. 1, p. 77 (1662).
[150] *Syst. Naturæ*, ed. 10, I, p. 567 (1758) (*Ichneumon puparum* Linn.).
[151] Packard, A. S., *Proc. Boston Soc. Nat. Hist.*, vol. 21, p. 30 (1881).
[152] Riley, C. V., U. S. Com. Agr., *Rept.*, 1883, pp. 111–112 (1883).
[153] Thomas, Cyrus, *Eleventh Rept.*, *Insects Ill.*, pp. 35–36 (1883).

country. In California, Alexander Craw secured a large number of adults reared at Long Beach by Frederick Maskew in 1899 or 1900, which he liberated in the San Francisco Bay region.[154] It is re-

FIG. 111.—The cabbage butterfly parasite, *Pteromalus puparum* (Linn.), ovipositing in the living chrysalis of the cabbage butterfly, *Pieris rapæ* (Linn.). This parasite is widely distributed throughout Europe and North America. (Photograph by S. B. Doten, 1911.)

ported widely distributed throughout the state just prior to 1908[155] and is generally considered to be the most important enemy of the cabbage butterfly, although it appears to do very little good in controlling this pest in California.

In 1911 Doten[156] studied the habits and reactions of this interesting parasite and took some very remarkable photographs of it.

[154] Craw, Alex., Calif. State Bd. Hort., *7th Bien. Rept.*, 1899–1900, pp. 67–68 (1901).

[155] Ehrhorn, E. M., Calif. State Hort. Com., *Proc.*, *33d Fruit Growers' Conv.*, p. 154 (1908).

[156] Doten, S. B., *Concerning the relation of food to reproductive activity and longevity in certain hymenopterous parasites*, Nevada Agr. Expt. Sta., Tech. Bul. 78, pp. 20–24, pls. 6–8 (1911).

In addition to the cabbage butterfly it attacks a wide variety of lepidopterous insects. It is also hyperparasitic on *Hyposoter fugitivus* (Say), *Rogas* spp., *Microbracon* spp., and other hymenopterous parasites.[157]

MISCOGASTERIDÆ [158] (Family).

Anysis saissetiæ (Ashmead) [159] was originally described in the genus *Eurycranium* by Ashmead in 1905 from three female and seven male specimens received from T. D. A. Cockerell and reared by C. H. T. Townsend from the scale, *Saissetia nigra* (Nietner) collected in the Philippine Islands. It is a tropical species also known in southern China and Formosa and also parasitic on the black scale and hemispherical scale. It was collected at Swatow, China, in December, 1924, by F. Silvestri and the lot consisting of 475 adults were received at the State Insectary, Riverside, January 16, 1925. Colonies of these were liberated in White Park, Riverside and other sections in southern California where black scale was present. One lot of cycad plants infested with black scale and parasitized by this insect was placed in an orchard at Riviera. A single adult was recovered at White Park, June 26, 1925, but the parasite has not appeared in any other place. It is very doubtful if it became permanently established in California.

Aphobetoideus comperei Ashm.[160] was described by Ashmead from material collected by George Compere at Swan River, near Perth, Western Australia, sometime between 1900 and 1903. It was not sent to California until 1921, when it was reared from black scale at Sydney, Australia, by E. W. Rust. The 48 adults recovered in the material received in November were used experimentally in the insectary, but it was impossible to rear it. The exact status of it as a parasite is still unknown, but there are indications that it may be a hyperparasite although Smith and Compere

[157] Dalla Torre, C. G. de, *Cat. Hymenopterorum*, vol. 5, p. 143 (1898).
Essig, E. O., *Insects of W. No. Am.* (N. Y., Macmillan, 1926), p. 822.

[158] This family is not listed in all the works on Hymenoptera. It belongs to the superfamily Chalcidoidea and is related to the Pteromalidæ, Eurytomidæ, and Perilampidæ.

[159] Ashmead, W. H., *Proc. U. S. Nat. Mus.*, vol. 29, p. 405 (1903).
Smith, H. S., and Compere, H., *Univ. Calif. Pub. Entom.*, vol. 4, p. 53 (1926); pp. 309–312, figs. 46–50 (1928).

[160] Ashmead, W. H., *Mem. Carnegie Mus.*, vol. 1, p. 328 (1904).
Smith, H. S., and Compere, H., *Univ. Calif. Pub. Entom.*, vol. 4, pp. 312–317, figs. 51–54 (1928).

think that it " does not normally develop at the expense of primary parasites." [161]

Tomocera californica Howard [162] (Fig. 112) was first collected in California by J. H. Comstock, who reared it from black scale in 1880. It was described the same year by Howard. This very interesting parasite was first believed to be native of California, but all of its known hosts are introduced species and it is found much more widely distributed, particularly in Australia, where it was collected in Queensland by George Compere and sent to California in 1900 and 1901 as an egg parasite of the black scale. It is now thought to have been accidentally introduced into California and into many other parts of the world. Specimens taken in Hawaii were described as *Moranila testaceipes* by Cameron in 1883. It is likely that the parasite was taken to Hawaii about the same time as to California. The chief host of this parasite in California is black scale with a record of accidental hyperparasitism on *Micro-*

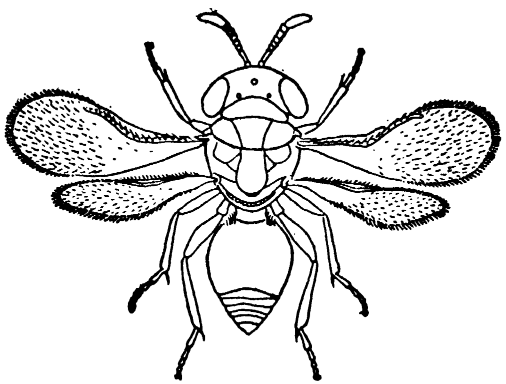

FIG. 112.—The California tomocera, *Tomocera californica* How., was probably very early introduced into California, where it was first reared from black scale by J. H. Comstock in 1880. (After L. O. Howard, 1881.)

[161] H. Compere writes me that when in Sydney in 1928 he "reared this species from a number of unrelated coccids which indicates that it may be a dangerous hyperparasite."—October, 1929.

[162] Howard, L. O., U. S. Dept. Agr., *Rept.*, 1880, pp. 368–369, pl. 24, figs. 3–4 (1881); *Entom. Am.*, vol. 2, p. 98 (1886) (*Dilophogaster*); *Can. Entom.*, vol. 28, p. 165 (1896).

Cameron, P., *Trans. Entom. Soc. London*, pp. 188–189 (1883) (*Moranila testaceipes* Cam.).

Riley, C. V., *Insect Life*, vol. 2, pp. 248–249 (1890) (*Dilophogaster*).

Craw, Alex., Calif. State Bd. Hort., *Rept.*, 1891, p. 286 (1892).

Isaac, John, *ibid.*, *Rept.*, 1903–1904, pp. 94–95, figs. 10–11 (1905).

Quayle, H. J., Calif. Agr. Expt. Sta., *Bul. 223*, pp. 189–190, fig. 13 (1911).

Timberlake, P. H., *Jour. Econ. Entom.*, vol. 6, p. 300 (1913).

Essig, E. O., Calif. State Hort. Com., *Inj. and Ben. Ins.*, pp. 272–273, fig. 270 (1913); ed. 2, pp. 373–374 (1915); *Insects W. No. Am.*, p. 825, fig. 692 (1926).

Fullaway, D. T., *Proc. Entom. Soc. Hawaii*, vol. 4, pp. 240–243 (1919).

Mercet, R. G., *Bol. Soc. Espan. Hist. Nat.*, vol. 24, pp. 2–6 (1924).

Smith, H. S., and Compere, H., *Univ. Calif. Pub. Entom.*, vol. 4, pp. 317–321, figs. 55–57 (1928).

terys flavus (How.) made by Timberlake. In other localities it also attacks *Saissetia hemisphærica* (Targ.), *S. nigra* (Nietn.), *Asterolecanium pustulans* (Ckll.), *Ceroplastes sinensis* Del G., *C. rubens* Mask., *C. rusci* (Linn.), and no doubt other species of coccids. In California it was quite effective shortly after its first introduction. *Scutellista cyanea* Mots. practically replaced it in 1902, although it still persists in southern California, wherever there is an abundance of black scale to breed upon.

The scutellista, *Scutellista cyanea* Motschulsky,[163] was one of the most promising parasites of the black scale. Smith and Compere [164] have given us a complete historical account of its introduction into California which I give in full: " *Scutellista cyanea* Motsch. is the best known of the parasites attacking coccids in California. It was first described in 1859 by Motschulsky from specimens reared by Nietner [165] from *Saissetia hemisphærica* (Targ.). In 1863, it was described by Costa [166] under the name *Aspidocoris cyanea* (*cyaneus*). In 1895 Howard received specimens of this parasite from Berlese, who reared them from *Ceroplastes rusci* L., collected in Italy. Howard realized the possible value of this parasite, and undertook the work of introducing it into the United States.[167] He

[163] Motschulsky, T. Victor von, *Étud. entom.*, vol. 8, p. 172, t. 1, f. 17 (1859).
Craw, Alex., *South African black scale parasite*, Calif. State Bd. Hort., 8th Bien. Rept., 1901–1902, pp. 91–99, fig. (1902).
Ehrhorn, E. M., *ibid.*, Rept., 1903–1904, p. 38 (1904).
Marlatt, C. L., U. S. Dept. Agr., Div. Entom., *Bul. 44*, pp. 50–56 (1904).
Isaac, John, Calif. State Hort. Com., *First Bien. Rept.*, 1903–1904, pp. 93–94, figs. 1–2, col. pl. iv (1905).
Schmiedeknecht, O., *Gen. Insectorum*, fasc. 97, p. 305, pl. 7, fig. 7 (1909).
Howard, L. O., and Fiske, W. F., U. S. Dept. Agr., Bur. Entom., *Bul. 91*, pp. 31–33, fig. 6 (1911).
Quayle, H. J., Calif. Agr. Expt. Sta., *Bul. 214*, pp. 456–459, fig. 7 (1911); *Bul. 223*, pp. 179–188, pls. 5–6 (1911).
Essig, E. O., *P. C. Jour. Entom.*, vol. 5, p. 55 (1913); *Inj. & Ben. Ins. Calif.*, pp. 270–271, fig. 268 (1913), ed. 2, p. 374, fig. 373 (1915); *Ins. of W. No. Amer.* (Macmillan, N. Y., 1926), p. 825, fig. 693.
Smith, H. S., and Compere, H., U. C. Pub., *Tech. Bul. Entom.*, vol. 4, pp. 322–332, figs. 58–60 (1928).

[164] *Op. cit.*, pp. 322–324 (1928).

[165] John Nietner did entomological work in Ceylon particularly on Coleoptera and the insect enemies of the coffee-tree. His specimens of scutellista were reared from the hemispherical scale, determined then as *Lecanium coffeæ* Sign., on coffee in Ceylon.

[166] Costa, A., *Bul. Accad. Aspir. Natur. Napoli*, p. 26 (1863). Costa also named it *A. myrti*, *ibid.*, p. 24.
Schmiedeknecht, Otto, *Gen. Insectorum*, fasc. 97, p. 305 (1909).

[167] With the aid of C. P. Lounsbury of South Africa Howard introduced the parasite into Florida and Louisiana in 1898, to work upon the wax scales, *Ceroplastes floridensis* Comstock and *C. cirripediformis* Comstock, but got no results. Through the efforts of S. F. Leib of San José and E. M. Ehrhorn of Mountain View,

worked out the synonymy and redescribed and figured the species. In Bulletin 91 of the Bureau of Entomology, he gives a detailed, first-hand account of the history of the introduction of *Scutellista cyanea* into the United States, based on the correspondence in the files of the Bureau of Entomology. In 1903, Marlatt spent two months in California investigating the work done by Scutellista, at the time when the parasite was at the peak of its abundance. In 1911, Quayle gave an account of the life-history of this parasite, with the history of its introduction and comments on its economic value. In the reports of the Commissioner of Horticulture of California, as well as in the entomological journals, are to be found several articles dealing with Scutellista in this state.

In November (October), 1901, Craw obtained seventeen living *Scutellista* from parasitized black scale infesting oleander cuttings shipped by Lounsbury from Cape Town. Prior to this, Ehrhorn had also obtained living specimens from the same source and had been successful in obtaining a second generation. He placed colonies in the orchards but they failed to become established. The living parasites were obtained only after many unsuccessful shipments had been made. Of the seventeen live *Scutellista* received by Craw, only four were females and one of these was killed by a spider. All of the *Scutellista* occurring in California today are supposedly descendants of the four (three) females obtained by Craw in 1901. He was remarkably successful in his work of propagating these parasites, for within one year he was sending colonies to various parts of the state. According to Howard, during the first year *Scutellista* was established in every county south of Point Conception and had become plentiful in Los Angeles, Orange, and San Diego counties. For a time the work of this parasite exceeded the most sanguine expectations and it was confidently predicted that the black scale was a thing of the past. There are numerous records in the old horticultural reports testifying as to the effective work done by this parasite, and to the great saving in money which resulted. Undoubtedly *Scutellista* did a great amount of good, much more

California, Lounsbury brought a small box of parasitized black scale to America, landing at New York, June 2, 1900. The box was forwarded by Dr. Howard to Ehrhorn, who temporarily established it around his home at Mountain View, but it soon disappeared and never became established. On Sept. 19, 1900, C. W. Mally of South Africa sent two more boxes containing scutellista direct to S. F. Leib at San José and a third lot in October, 1900. Both lots failed as before. On February 28, 1901, another lot was forwarded by Lounsbury in the cold chamber of the boat to England and thence direct to California. It was delayed by customs officials and the few parasites which emerged failed to propagate. On October 1, 1901, Lounsbury sent still another lot by letter post direct to California. It reached Craw on October 31, 1901, and the few that emerged were the parents of all Scutellista now in this state. The first lot was sent to Los Angeles, June 9, 1902, and liberated on a pepper tree infested with black scale at Pasadena. By July Craw distributed 25 colonies chiefly in southern California. In 1903 it was estimated that 90% of the black scale was killed by it.—Howard and Fiske, *op. cit.*, pp. 31–33 (1911); Craw, A., *op. cit.*, p. 91 (1902).

than it has in subsequent years, yet it seems to us that the worth of this parasite was over-estimated by many. In 1903, Marlatt spent November and December in southern California investigating the work of *Scutellista.* On the basis of first-hand observation, supplemented by information obtained from local horticultural officials, Marlatt published a detailed account of the work done by *Scutellista* up to the year 1904. At this time the parasite was at the peak of its abundance and was credited with having destroyed the heavy infestation of black scale in the coastal area. In the interior districts, where the even-hatch condition prevailed, *Scutellista* proved a disappointment, for it failed to do the same effective work it was credited with doing in the coastal area, where the uneven-hatch condition exists. The best account of this species was published in 1911 by Quayle, in which he undoubtedly gives a much more correct approximation of the true worth of *Scutellista* than did earlier investigators. What Quayle stated in 1911 concerning the economic importance and status of this parasite in California, holds true at the present time, so far as our observations go.

Distribution. *Scutellista cyanea* Motsch. is supposedly an Old World species, being accidentally or purposely introduced into the other countries. It is now of nearly world-wide distribution, having been recorded from many temperate and subtropical regions. In an unpublished note George Compere records having taken this parasite in Spain, France, Italy, Ceylon, and India, at Jaffa, and in three cities in China, namely, Hongkong, Canton, and Swatow. To this list can be added: South Africa, New South Wales, Hawaiian Islands, and the United States. Within the United States this parasite occurs in California and Louisiana. In California *Scutellista* generally occurs wherever its hosts are found. It is very commonly encountered in the citrus belt of southern California. It may occur much more abundantly at certain times in some groves than in others, yet if living scales are present and in the proper stage, *Scutellista* will soon be found parasitizing them.

Hosts. The recorded hosts of *Scutellista cyanea* Motsch. are: *Saissetia hemisphærica* (Targ.), *Ceroplastes rusci* (Linn.), *Phenacoccus artemisiæ* Ehrh., *Saissetia nigra* (Nietn.), *Coccus hesperidum* (Linn.), and *Saissetia oleæ* (Bern.). To this record we can add *Saissetia perseæ* Brain. In California *Scutellista* is best known as a parasite of *Saissetia oleæ.* It rarely parasitizes the other coccids mentioned as hosts, namely, *Coccus hesperidum* and *Phenacoccus artemisiæ.*

The failure of *Scutellista* in California has probably been largely due to hyperparasites, the first of which was noted by Quayle [168] in 1911 and designated as *Cerchysius* sp. It proved to be a new species and was named *Cerchysius whittieri* by Girault [169] in 1918 and changed to *Quaylea whittieri* (Girault) after its discoverer by Timberlake [170] in 1929 (see same, p. 358).

[168] *Op. cit.*, pp. 187–188 (1911).
[169] Girault, A. A., *Entom. News*, vol. 29, p. 66 (1918).
[170] Timberlake, P. H., *Proc. Entom. Soc. Hawaii*, vol. 4, pp. 214–218 (1920).

Ophelosia crawfordi Riley [171] was discovered at Adelaide, Australia in 1889 by F. S. Crawford who forwarded specimens to C. V. Riley the same year. Riley named it after its discoverer in 1890. Kœbele first learned of the insect through H. Tryon at Brisbane on his first trip to Australia in 1889 and noted it again on March 26, 1892. It was reared in California from eggs of the cottony cushion scale sent over by Kœbele that year. In 1900 George Compere also collected material and forwarded it to Alexander Craw, who reared and distributed it in the state. This insect apparently never became established in California.

APHELINIDÆ (Family). Aphelinid Parasites.

Aneristus ceroplastæ Howard [172] (*Coccophagus orientalis* Howard) [173] is a tropical species described by Howard in 1895 from specimens reared from *Ceroplastes euphorbiæ* Ckll. in Jamaica. It has since been reared in Ceylon from *C. actiniformis* Green, *Coccus viridis* (Green) and *Saissetia hemisphærica* (Targ.); in South China from *Saissetia oleæ* (Bern.); in Hawaii from *Coccus longulus* (Dougl.), *Saissetia hemisphærica* (Targ.), and *S. nigra* (Nietn.); and is also reported in the Philippine Islands, St. Croix, Virgin Islands, and Ancon, Canal Zone. It was brought to California by E. W. Rust, who collected it in Hawaii in December, 1921. It is thought to be a primary parasite, but attempts to rear it on black scale in confinement proved unsuccessful and the parasite perished.

[171] Riley, C. V., *Insect Life*, vol. 2, pp. 248–250, 320–321 (1890); vol. 5, p. 207 (1893).
Kœbele, A., U. S. Dept. Agr., Div. Entom., *Bul. 21*, p. 23 (1890); *Studies of parasitic and predaceous insects in New Zealand, Australia, and adjacent islands*, U. S. Dept. Agr., p. 39 (1893).
Tryon, H., *Rept. on insect and fungous pests*, no. 1, Queensland Mus., 238 pp., 4 pls. (1889) (contains description of this insect without naming it).
Craw, Alex., Calif. State Bd. Hort., *7th Bien. Rept.*, 1899–1900, p. 66 (1901).
Essig, E. O., *Insects W. No. Am.*, p. 825 (1926).

[172] Howard, L. O., *Can. Entom.*, vol. 27, p. 351 (1895); *Psyche*, vol. 7, suppl., p. 18 (1896); *Proc. U. S. Nat. Mus.*, vol. 18, p. 633 (1896) (*Coccophagus orientalis* How.).
Girault, A. A., *Bul. Brooklyn Entom. Soc.*, vol. 12, p. 88 (1917).
Gahan, A. B., *Proc. U. S. Nat. Mus.*, vol. 36, art. 4, pp. 13, 14 (1924).
Timberlake, P. H., *Proc. Entom. Soc. Hawaii*, vol. 3, p. 404 (1918) [*Prococcophagus orientalis* (How.)].
Smith, H. S., and Compere, H., *Univ. Calif. Pub. Entom.*, vol. 4, pp. 246–247, figs. 3–4 (1928).

[173] Howard, L. O., *Proc. U. S. Nat. Mus.*, vol. 18, pp. 633–634 (1895).
Mercet, R. G., *Los Afelininos*, Trabajos del Museo de Ciencias Nat., no. 10, pp. 243–244 (1912).
Smith, H. S., Calif. State Hort. Com., *Mthly. Bul.*, vol. 4, pp. 446, 542 (1915).
Smith, H. S., and Compere, H., *Univ. Calif. Pub. Entom.*, vol. 4, pp. 53–56 (1926).

The synonym *Coccophagus orientalis* Howard was described from thirteen specimens reared from *Ceroplastes actiniformis* Green, *Coccus viridis* (Green), *Saissetia hemisphærica* (Targ.), and *Pseudococcus longispinus* (Targ.) by the eminent coccidologist, E. E. Green, in Ceylon, where it is a common parasite on scale insects.

Aphytis [174] *mytilaspidis* (Le Baron) [175] (*Aphelinus*) is a widely distributed cosmopolitan species, common in many parts of Europe and appears also to be a native of much of North America and other temperate regions. Its work was probably first noted in the United States by Asa Fitch in New York, but the insect was first described by Le Baron in 1870 from specimens reared from the oyster shell scale, *Lepidosaphes ulmi* (Linn.), in Illinois. It is very probable that it was early introduced into California on this host and has become well distributed throughout the state. The most important hosts, aside from the oyster shell scale, are: the ivy scale, *Aspidiotus hederæ* (Vall.), walnut scale, *A. juglans-regiæ* Comst., pear tree oyster scale, *A. ostreæformis* Curtis, San José scale, *A. perniciosus* Comst., rose scale, *Aulacaspis rosæ* (Bouché), juniper scale, *Diaspis carueli* Targ., pine leaf scale, *Chionaspis pinifoliæ* (Fitch), parlatoria date scale, *Parlatoria blanchardi* (Targ.), aspidistra scale, *Pinnaspis aspidistræ* (Sign.), and *Leucaspis pini* (Hartig) (in Europe).

The common chalcid, *Aphytis diaspidis* (Howard) [176] (*Aphelinus*, *A. fuscipennis* How.), is a cosmopolitan species which must surely have been accidentally introduced into California at a comparatively early date along with one or perhaps many of the hosts

[174] I am following the suggestion of P. H. Timberlake in referring this and all of the following species, excepting *Aphelinus mali* (Hald.), to the genus *Aphytis*.

[175] Le Baron, Wm., *Am. Entom.*, vol. 2, p. 360, fig. 220 (1870); *Second Rept. State Entom., Ill.*, 1870, p. 34 (1871).

Riley, C. V., Fifth Ann. Rept., *Insects of Missouri*, pp. 88, 100, fig. 34 (1873).

Howard, L. O., U. S. Dept. Agr., *Rept.*, 1880, pp. 354–355, pl. 23, fig. 1 (1881); *ibid.*, Div. Entom., Tech. Ser. 1, pp. 25–26 (1895).

Masi, L., *Boll. Lab. Zoöl. Gen. Agr.*, Portici, vol. 5 (1911).

Mercet, R. G., *Los Afelininos*, Trabajos del Museo de Ciencias Nat., no. 10, pp. 82–84 (1912).

Griswold, Grace H., Cornell Univ., Agr. Expt. Sta., *Mem. no. 93*, 66 pp., 21 figs. (1925).

Essig, E. O., *Insects W. No. Am.*, p. 828 (1926).

[176] Howard, L. O., U. S. Dept. Agr., *Rept.*, 1880, p. 355 (1881); *Insect Life*, vol. 6, p. 233, fig. 9 (1894); U. S. Dept. Agr., Div. Entom., *Tech. Ser. 1*, pp. 26–27 (1895).

Schmiedeknecht, O., *Gen. Insectorum*, fasc. 97, p. 452, pl. 8, fig. 1 (1909).

Quayle, H. J., *Jour. Econ. Entom.*, vol. 3, pp. 398–401 (1910).

Mercet, R. G., *Los Afilininos*, Trabajos del Museo de Ciencias Nat., no. 10, pp. 72–74, fig. 16 (1912).

Essig, E. O., *Insects W. No. Am.*, p. 827 (1926).

which it commonly infests. It was originally described from Florida by Howard in 1881 and as it has but a limited distribution in this country, it appears to be of foreign origin. At present it is known to occur in the United States, the Mediterranean region, China, Japan, Guam, Western Australia, and Madeira. The known hosts are: the rose scale, *Aulacaspis rosæ* (Bouché), West Indian peach scale, *A. pentagona* (Targ.), the minor scale, *Hemichionaspis minor* (Mask.), greedy scale, *Aspidiotus camelliæ* Sign., coconut scale, *A. destructor* Sign., walnut scale, *A. juglans-regiæ* Comst., San José scale, *A. perniciosus* Comst., oyster shell scale, *Lepidosaphes ulmi* (Linn.), red scale, *Chrysomphalus aurantii* (Mask.),[177] Spanish red scale, *C. dictyospermi* (Morg.). The insect which has been known as *Aphelinus fuscipennis* Howard, is according to Timberlake, " identical with *diaspidis*, at least no one has ever successfully distinguished them." While it is so treated here I am giving its history separately in order to avoid confusion. *A. fuscipennis*[178] was described by Howard in 1881 from specimens reared from San José scale, *Aspidiotus perniciosus* Comst., at San José, Los Angeles, and San Francisco, Calif., and at New Brunswick, N. J., and Riverside, Md.; from the euonymus scale, *Chionaspis euonymi* Comst., from Fort George, Fla.; from Glover's scale, *Lepidosaphes gloveri* (Packard), in greenhouse, District of Columbia; and from oyster shell scale, *L. ulmi* (Linn.), in the District of Columbia. Although it is now widely distributed throughout North America and many other temperate regions where the San José scale has been introduced, it is thought to have originated in China and Japan, the natural home of the San José scale. It was no doubt introduced into California along with the San José scale in 1870. It appears to be fairly abundant throughout the state and many claims have been made for its efficiency in reducing and effectively controlling the pest, but no accurate observations or experiments have ever been made to substantiate these claims.

[177] H. Compere calls attention to the fact that so far he has never obtained this parasite from red scale and doubts the previous records listing the red scale as a host of it.

[178] Howard, L. O., U. S. Dept. Agr., *Rept.*, 1880, p. 356 (1881); *ibid.*, Div. Entom., *Tech. Ser. 1*, p. 27 (1895).

Calif. State Bd. Hort., *Ann. Rept.*, 1889, p. 283, fig. 134 (1890).

Johnson, W. G., U. S. Dept. Agr., Div. Entom., *Bul. 26* n. s., pp. 73–75 (1900); Entom. Soc. Ontario, *31st Ann. Rept.*, pp. 103–105 (1901).

Mercet, R. G., *Los Afelininos*, Trabajos del Museo de Ciencias Nat., no. 10, pp. 75–76 (1912).

Essig, E. O., *Insects W. No. Am.*, p. 827.

In addition to the hosts listed above, this parasite has also been reared from the greedy scale, *Aspidiotus camelliæ* Sign., ivy scale, *A. hederæ* (Vall.), the grape scale, *A. uvæ* Comst., the cactus scale, *Diaspis echinocacti* (Bouché), Florida red scale, *Chrysomphalus aonidum* (Linn.), and other scales in America and other countries. It has never been artificially propagated for liberating into orchards to control any of these pests in California.

Several other species, *Aphytis chrysomphali* (Mercet) [*Aphelinus, A. quaylei* (Rust)], often confused with *A. diaspidis* (How.), *A. longiclavæ* (Mercet), and the related *Aphelinus mali* (Hald.), have been introduced into California. (For list of hosts see Insects of W. No. Am., p. 828, 1926.)

The yellow scale parasite, *Aspidiotiphagus citrinus* (Craw),[179] is the most important and most widely distributed cosmopolitan species of this family of minute scale parasites. It was first noted by D. W. Coquillett, who reared it from yellow scale at San Gabriel in 1887. This find interested the California State Board of Horticulture, and Alexander Craw was commissioned to make an examination of the parasite and its possible value to the citrus orchardists. As the exact systematic status of the insect was still unknown the reports made by Craw may refer to other scale parasites as well as to this particular one. Many letters were addressed to the Secretary of the Board giving glowing accounts of the wonderful work of this new parasite and it was confidently believed that it would give the needed control of the pest. Specimens sent to Riley by Coquillett were determined as a new and undescribed species of *Coccophagus* by Howard and this statement was published by Coquillett in the "California Fruit Grower, September 21, 1889." With all of this information in hand Craw published a description

[179] Craw, Alex., Calif. State Bd. Hort., *Rept.*, 1890, pp. 348–349 (1890); *ibid.*, *Destructive insects*, pp. 28–29, fig. 32 (1891) (*Coccophagus*); *Rept.*, 1891, pp. 219–222 (1892).

Riley, C. V., and Howard, L. O., *Insect Life*, vol. 4, p. 168 (1891) (*Encarsia*).

Howard, L. O., *ibid.*, vol. 6, pp. 229–231, fig. 6 (1894); U. S. Dept. Agr., *Tech. Ser. 1*, p. 31, fig. 10 (1895).

Isaac, John, Calif. State Hort. Com., *First Bien. Rept.*, 1903–1904, p. 95, fig. 12, col. pl. 3, figs. 1, 1a (1905).

Doane, R. W., *Jour. Econ. Entom.*, vol. 1, pp. 341–342 (1908).

Schmiedeknecht, O., *Gen. Insectorum*, fasc. 97, p. 457, pl. 8, fig. 4 (1909).

Mercet, R. G., *Los Afilininos*, Trabajos del Museo de Ciencias Nat., no. 10, pp. 173–175, fig. 40 (1912).

Malenotti, E., *Redia*, vol. 12, pp. 15–18 (1917).

Paoli, G., *Revision del genere* Aspidiotiphagus *How.*, Boll. Soc., Entom., Ital., vol. 58, pp. 97–105, 3 figs. (1926).

Essig, E. O., *Insects W. No. Am.*, p. 829, figs. 695–696 (1926).

and figure of the parasite in 1891, calling it the yellow scale parasite, *Coccophagus citrinus*. Riley and Howard relegated it to the genus *Encarsia* in 1891 and Howard erected a new genus, *Aspidiotiphagus*, for it in 1894. Although this insect is common and often abundant in California, it has afforded no evident valuable control of any of its many hosts although it may be a far greater factor in this respect than is suspected at this time. Ehrhorn[180] in 1908 suspected its introduction into California, but no idea was given as to its native home. Since then it has been found to be exceedingly widely distributed throughout the world and is now known to occur in California, Hawaii, Jamaica, Barbados, Tahiti, Fanning Island, Guam, and many of the South Pacific Islands, Argentine Republic, Bolivia, Brazil, Chile, Spain, Italy, Sicily, France, Germany, Switzerland, Morocco and other parts of North Africa, and the Mediterranean region, Trinidad, and Ceylon. It was first reared from the yellow scale, *Chrysomphalus citrinus* (Coq.), but also attacks red scale, *C. aurantii* (Mask.), Florida red scale, *C. aonidum* (Linn.), Spanish red scale, *C. dictyospermi* (Morg.), aspidistra scale, *Pinnaspis aspidistræ* (Sign.), minor scale, *Hemichionaspis minor* (Mask.), pineapple scale, *Diaspis bromeliæ* (Kern), cactus scale, *D. echinocacti* (Bouché), rose scale, *Aulacaspis rosæ* (Bouché), West Indian peach scale, *A. pentagona* (Targ.), purple scale, *Lepidosaphes becki* (Newm.), oyster shell scale, *L. ulmi* (Linn.), Putnam's scale, *Aspidiotus ancylus* (Putnam), coconut scale, *A. destructor* Sign., ivy scale, *A. hederæ* (Vall.), San José scale, *A. perniciosus* Comst., hemlock scale, *A. pini* Comst., soft brown scale, *Coccus hesperidum* Linn., and probably a large number not yet recorded. In the South Sea Islands it is specially effective on the aspidistra scale and the coconut scale.

Azotus perspeciosus (Girault) (*A. silvestrii* Compere)[181] was collected at Shanghai, China, by F. Silvestri late in 1924 and was supposedly reared from Florida red scale, *Chrysomphalus aonidum* (Linn.), but according to Compere it may have reproduced at the expense of *Aphytis diaspidis* (Howard), which was present in the material sent to California by Silvestri. Two adults were reared, Jan. 24, 1925, but no attempt was made to colonize them.

[180] Ehrhorn, E. M., Calif. State Hort. Com., *Proc. 33d Fruit Growers' Conv.*, pp. 151–152 (1908).

[181] Compere, H., *Univ. Calif. Pub. Entom.*, vol. 4, pp. 9–11, fig. 3 (1926). Girault places this species in the genus *Ablerus*.

Casca chinensis Howard [182] was probably the species collected in China by George Compere in 1900. He purchased in China a small orange tree infested with red scale which in turn was parasitized with a small parasite. The tree reached San Francisco, November 30, 1900, and was placed in a glass breeding cage. From this tree were reared a total of 647 adult parasites, which were liberated in citrus orchards infested with red scale in Orange and Los Angeles counties. In reply to an inquiry from me as to the possibility of this parasite being *Comperiella*, H. S. Smith, on Feb. 2, 1929, wrote as follows: "I think there is no possibility of the parasite referred to [183] being *Comperiella*. You will note that this article says the parasite is slightly smaller than *Aspidiotiphagus citrinus*. *Comperiella* is much larger than this latter parasite and furthermore is dark bluish-green in color, almost black. The parasite referred to by Craw is undoubtedly one of the species of *Casca*, either *chinensis* Howard, or *smithi* Silvestri (MSS.), both of which seem to attack *Chrysomphalus aurantii* (Mask.) in China."

In 1907 Howard described the genus *Casca* and the species *chinensis* from two females reared from the purple scale, *Lepidosaphes becki* (Newm.), collected in China by Compere. According to Smith and Compere, George Compere was trying to introduce this same parasite into California from Hawaii in 1906.[184] In 1924 F. Silvestri collected and sent to California material from which 650 living adults were reared, of which 378 specimens were liberated on citrus trees, infested with red scale on the property of the San Joaquin Fruit Company near Tustin, Orange County; 211 specimens were liberated in White Park, Riverside, on three California bay trees infested with red scale; and several small colonies were liberated on citrus trees infested with red scale on the properties of the Citrus Experiment Station, Riverside. Although the parasite persisted for several months on red scale on aspidistra in confine-

[182] Craw, Alex., Calif. State Bd. Hort., *Eighth Bien. Rept.*, 1901-1902, p. 192 (1902). This refers either to *Casca chinensis* How. or *C. smithi* Silvestri (MSS.), both of which attack red scale in China.

Howard, L. O., U. S. Dept. Agr., Bur. Entom., *Tech. Ser. 12*, pp. 83-84, fig. 20 (1907).

Schmiedeknecht, O., *Gen. Insectorum*, fasc. 97, p. 461, pl. 8, fig. 6 (1909).

Compere, H., and Smith, H. S., *Univ. Calif. Pub. Entom.*, vol. 4, pp. 71-73, figs. 11-13 (1927).

[183] Craw, Alex., *op. cit.*, p. 192.

[184] Craw had removed to Hawaii. In his Report of the Division of Entomology, Hawaiian Board of Agriculture and Forestry, pp. 151-152, fig. 3, December, 1906, he figured Florida red scale with about five parasite exit holes, a condition according to Compere and Smith, "characteristic of the work of *Casca*." (Fig. 113.)

ment, it has never been recovered in the field from any of the colonies liberated by Craw or by Smith. Although Silvestri noted several species of *Casca* in China, Smith reports but one species *chinensis* received and reared at the insectary at Riverside, which is presumably the one received from Compere by Craw.[185] It has

FIG. 113.—The red scale parasite, *Casca* sp. Insect, the Florida red scale, *Chrysomphalus aonidum* (Linn.), on a cycad leaf from China, showing the numerous exit holes of the parasite. At the right, the potted cyad, infested with the parasitized Florida red scale, placed beneath an orange tree, infested with the same scale in the Government Nursery in Hawaii, in an attempt to transfer the parasite to the scales on the tree. This method was commonly employed by the early insect collectors. (After Alexander Craw, 1906.)

been reared from red scale, *Chrysomphalus aurantii* (Mask.), Florida red scale, *C. aonidum* (Linn.), purple scale, *Lepidosaphes becki* (Newm.), and *Lepidosaphes* sp. (thought to be *L. tubulorum* Ferris).

[185] However Compere and Smith refer to letters from Silvestri stating that the species given the MS. name *smithi* is the more important of the two in China. *Op. cit.*, p. 71. H. Compere has just furnished this information concerning the various species of *Casca:* "According to Silvestri *Casca chinensis* has been misdetermined by us. He states that *Casca chinensis* How. is restricted to *Lepidosaphes becki* (Newm.). *Casca smithi* Silv. (MSS.) attacks *Chrysomphalus aonidum* (Linn.) in South China, the Philippines, and Formosa. *Casca auranticola* Silv. (MSS.) attacks *Chrysomphalus aurantii* (Mask.) at Nara, Japan."

Coccophagus anthracinus Compere [186] was sent to California from Cape Town, South Africa, by E. W. Rust in September, 1923. From this material 2000 specimens were reared six weeks after the arrival of the original shipment. It is parasitic on black scale and although given every opportunity, it has not been recovered in the field.

Coccophagus atratus Compere [187] was described from 44 females and 1 male reared from *Ceroplastes* sp., collected by E. W. Rust at Cape Town, South Africa, shipped July 11, 1924, and received at the insectary at Riverside, Calif., Aug. 12, 1924. Adults issued in August of that year, but no statement is made as to the colonizing of the same, so it is presumed that no liberations in the orchards were made.

Coccophagus gurneyi Compere,[188] a parasite of the citrophilus mealybug, *Pseudococcus gahani* Green, was discovered in New South Wales, Australia, in 1928 by H. Compere, who collected material for shipment to California during the period from August, 1928 to March, 1929. Compere brought it to California personally and arrived at Riverside in March, 1929, with sufficient material to rear the parasite in quantities in the insectary. This promising species has been liberated in the citrus orchards of southern California in the sections where the citrophilus mealybug is abundant and great hopes are being held that it will afford an efficient control for this troublesome pest.

Coccophagus japonicus Compere [189] was collected at Yokohama, Japan, in 1922 and received at the Whittier laboratory in California June 4, 1922. From the shipment of parasitized citricola scale, *Coccus pseudomagnoliarum* (Kuw.), one male and several females were recovered. A second shipment was received from C. P. Clausen on June 3, 1923, from which 515 adults emerged. Liberations were made in the orchards of southern California as follows: R. K. Pitzer, Pomona, 125 adults, June 7, 1922, on citricola scale; Huntington Estate, San Marino, Los Angeles County, 60 adults,

[186] Compere, H., *Univ. Calif. Pub. Entom.*, vol. 3, pp. 309–311, pls. 25–26 (1926); vol. 4, p. 11, fig. 14 (1926).
Smith, H. S., and Compere, H., *ibid.*, vol. 4, p. 247 (1928).

[187] Compere, H., *Univ. Calif. Pub. Entom.*, vol. 4, pp. 2–4, fig. 1 (1926).

[188] Smith, H. S., and Compere, H., *Jour. Econ. Entom.*, vol. 21, pp. 664–669 (1928).
Compere, H., *Univ. Calif. Pub. Entom.*, vol. 5, pp. 1–3, figs. 1–2 (1929).

[189] Smith, H. S., Calif. State Dept. Agr., *Mthly. Bul.*, vol. 11, p. 829 (1922); vol. 12, pp. 336, 337 (1923).
Compere, H., *Bul. So. Calif. Acad. Sci.*, vol. 23, p. 122 (1924).

June 7, 1922, on soft brown scale; R. K. Pitzer, Pomona, 60 adults, June 11, 1922, on citricola scale; Highway, Pomona, 60 adults, June 11, 1922, on citricola scale. It is a promising parasite but field recoveries have not yet been published.

Coccophagus lecanii (Fitch) [190] and *C. lunulatus* How.[191] are two common widely distributed parasites occurring in California, which attack unarmored scales. They also have a rather wide world distribution. The former is known in the United States, Canada, West Indian Islands, Europe, South Africa, Japan and is recorded on 18 different species of scale insects. The latter is not so extensively distributed, but is known in the United States, Australia, South Africa, and southern Europe, and attacks some half dozen species of coccids. Either or both of these species may be indigenous to California on native species of *Lecanium* or they could readily have been introduced many times.

Coccophagus malthusi Girault [192] was described from specimens reared from *Ceroplastes* sp. at Uitenhage, South Africa, by C. P. Lounsbury, in 1917. Specimens consisting of 4 males were received by the state insectary from Cape Town, Africa, April 16, 1914, and 82 females from E. W. Rust, August 12, 1924, from the same place, reared from *Ceroplastes* sp. It was not colonized in California.

Coccophagus modestus Silvestri [193] is an important internal parasite of black scale, *Saissetia oleæ* (Bern.), which was described by Silvestri in 1914 from specimens received from Dahomey, West Africa, as a variety of *C. orientalis* Howard. His variety has since been given specific rank. In 1914 C. P. Lounsbury began sending parasitized specimens of black scale to California from which were reared among other parasites, *C. modestus* Silv. Sufficient adults had been recovered so that in 1914 and 1915 strong colonies had been liberated in orchards infested with black scale at Niles and at Monrovia and specimens were kept in the insectary until 1915.

[190] Essig, E. O., *Insects W. No. Am.*, pp. 830–831, fig. 698 (1926).
Smith, H. S., and Compere, H., *Univ. Calif. Pub. Entom.*, vol. 4, pp. 247–254, figs. 5–9 (1928). Complete bibliography and account.

[191] Essig, E. O., *Insects W. No. Am.*, pp. 831–832, fig. 699 (1926).
Smith, H. S., and Compere, H., *Univ. Calif. Pub. Entom.*, vol. 4, pp. 254–257, fig. 10 (1928). Complete bibliography and account.

[192] Girault, A. A., *Desc. Stellarum Novarum*, Wash., D. C., p. 19 (May, 1917).
Compere, H., *Univ. Calif. Pub. Entom.*, vol. 4, pp. 5–9, fig. 2 (1926).

[193] Silvestri, F., Boll Lab. Zoöl. Agr., *Portici*, vol. 9, pp. 355–357, 1 fig. (1914) (*Coccophagus orientalis* var. *modesta* Silv.).
Smith, H. S., Calif. State Dept. Agr., *Mthly. Bul.*, vol. 11, p. 830 (1922).
Smith, H. S., and Compere, H., *The establishment in California of* Coccophagus modestus *Silv.*, Univ. Calif. Pub. Entom., vol. 4, pp. 51–61, 2 figs. (1926).

It has since been found in Sicily and South Africa. In 1915 Smith received a colony of the parasite from C. W. Mally, Cape Town, South Africa, which was liberated on black scale in the orange orchards at Fair Oaks, Calif., and another in the southern part of the state. In 1918 E. J. Vosler returned with a colony from Epping, New South Wales, which was increased in the insectary and liberated in central California, but the original stock perished in the insectary. E. W. Rust began forwarding colonies from Cape Town, South Africa, in 1921 [194] and continued until 1924, when the parasite was finally established and recovered in the orchards. First colonies from Rust were liberated at Santa Barbara and Chula Vista. A small colony liberated in White Park, Riverside, during the fall and winter of 1924 became established and 600 specimens were recovered from black scale taken in this park in June, 1925, and liberated in Balboa Park, San Diego. Other recoveries were made in March, 1926.

From the above-mentioned recoveries it appears that the parasite can reproduce under California conditions and it is expected that recoveries may soon be made from the citrus orchards of the state where liberations have been made.

Coccophagus ochraceus Howard [195] was originally described from three males and one female reared from *Lecanium* (*L. corni* Bouché?) on greasewood, at Alameda, July, 1887, by A. Kœbele. Were it not for the fact that the supposed host is an introduced insect, it might be argued that the parasite was native to California. C. P. Lounsbury reared it from black scale at Cape Town, South Africa, in 1909. In 1921 Rust began sending material to California from South Africa, until in October of that year I reared a large number of specimens from black scale on oleander on the campus of the University of California. The following year 1922 Compere and Armitage collected it in various localities. Since it was found

[194] A small colony was liberated on the property of Mrs. Jessium at Whittier in 1921, but it is doubtful if established.

[195] Howard, L. O., U. S. Dept. Agr., Div. Entom., *Tech. Ser. 1*, pp. 38–39 (1895).
Mercet, R. G., *Los Afelininos*, Trabajos del Museo de Ciencias Nat., no. 10, pp. 242–243 (1912).
Girault, A. A., *Soc. Entom.*, vol. 31, p. 44 (1916) (*C. bifasciaticorpus* Gir.).
Calif. State Dept. Agr., *Mthly. Bul.*, vol. 11, p. 830 (1922).
Gahan, A. B., *Proc. U. S. Nat. Mus.*, vol. 65, art. 4, p. 13 (1924).
Essig, E. O., *Insects W. No. Am.*, pp. 831–832 (1926).
Smith, H. S., and Compere, H., *Univ. Calif. Pub. Entom.*, vol. 4, pp. 259–261, fig. 11 (1928).

to be thoroughly established in a number of places in California no further attempts were made to introduce it. If an introduced species it was accidentally brought into the state at an early date and became established without any aid whatsoever. In South Africa it is rated as one of the most important parasites of black scale, being exceeded only by *C. trifasciatus* Compere. In California it appears to have made little headway during the past forty-two years it has been known to exist here.[196]

Coccophagus trifasciatus Compere [197] considered by Rust to be the most important parasite of the black scale in South Africa, was first sent to California by Lounsbury as early as 1912. In 1923 Rust began forwarding material to California from the same locality but it was not until 1924 and 1925 that the insectary succeeded in rearing it in sufficient quantities for liberation. During that period more than a thousand adults were secured. During the fall of 1924, 168 adults were liberated in White Park, Riverside, and other colonies consisting of 50 to 200 adults were colonized in orchards in Los Angeles, Orange, and San Diego counties. The only specimens recovered were from White Park, Riverside, so it is not yet ascertained if the parasite is established in the orchards.

Coccophagus yoshidæ Nakayama [198] was reared from soft brown scale, *Coccus hesperidum* Linn., in Shizuoka-ken, Japan, in 1921 by Nakayama. C. P. Clausen found it breeding on the above host and also on the citricola scale, *Coccus pseudomagnoliarum* (Kuw.), and sent material collected at Yokohama, Japan, to California, which was received on June 4, 1922, from which 27 adults issued, and a second lot was received on June 3, 1923, from which 9 adults issued. Adults were reared from the material and given the very best conditions possible for propagating in the insectary, but the insect failed to reproduce and was lost.

Marietta mexicana (Howard) [199] was described by Howard in

[196] H. Compere has just informed me that this parasite, within recent years, since 1922, has become one of the most common parasites of the black scale.

[197] Compere, H., *Univ. Calif. Pub. Entom.*, vol. 3, pp. 311–313, pl. 26, figs. 14 A–D (1925).

Smith, H. S., and Compere, H., *ibid.*, vol. 4, p. 53 (1926); p. 263 (1928).

[198] Nakayama, S., *Philippine Jour. Sci.*, vol. 18, pp. 98–99, pl. 1, fig. 1 (1921).

Smith, H. S., Calif. State Dept. Agr., *Mthly. Bul.*, vol. 11, p. 829 (1922); vol. 12, p. 336 (1923).

Compere, H., *Bul. So. Calif. Acad. Sci.*, vol. 23, pt. 4, p. 119 (1924).

Smith, H. S., and Compere, H., *Univ. Calif. Pub. Entom.*, vol. 4, pp. 263–264 (1928).

[199] Howard, L. O., U. S. Dept. Agr., Div. Entom., *Tech. Ser. 1*, pp. 22–23, fig. 5B (1895) (*Perissopterus mexicanus* How.).

1895 from specimens reared from soft brown scale, *Coccus hesperidum* (Linn.), yucca mealybug, *Puto yuccæ* (Coq.), and *Ceroplastes* sp. collected at Guadalajara, Mexico, by C. H. T. Townsend. Since then it has been reared from a number of coccids in southern California, where Smith thinks it was probably accidentally introduced. In 1911 I reared a large number from the chamise scale, *Lecaniodiaspis rufescens* (Ckll.). The adults were determined by Howard. Until 1923, when Compere found it was parasitic on *Metaphycus lounsburyi* (How.), through black scale, at Fillmore, Ventura County, Calif., it was generally supposed to be a primary parasite. It has since been reared from the West Indian peach scale, *Aulacaspis pentagona* (Targ.), in Japan by Nakayama. Apparently it has a wide distribution and is undoubtedly indigenous to California as well as to Mexico and is one of the unfortunate natural checks of beneficial parasitic species.

Marietta carnesi (Howard) [200] was reared from purple scale, *Lepidosaphes becki* (Newm.), in China by Geo. Compere, and specimens sent to Howard were described in 1910. It was found in some of the shipments of *Comperiella bifasciata* How. from Japan sent by Silvestri in 1924, but as it was known to be a secondary parasite all living specimens were destroyed.[201]

ENCYRTIDÆ (Family). Encyrtid Parasites.

Anagyrus aurantifrons Compere [202] is a mealybug parasite reared from *Pseudococcus* sp. on oleander at Cape Town, South Africa, by E. W. Rust and sent to California in July and August, 1924. It failed to propagate on any of the common species of mealybugs in California.

Anicetus annulatus Timberlake [203] was first noted in the Hawaiian Islands by D. T. Fullaway on April 25, 1912, where it occurs as a parasite of the tessellated palm scale, *Eucalymnatus tessellatus*

Mercet, R. G., *Los Afelininos*, Trabajos del Museo de Ciencias Nat., no. 10 pp. 119–120 (1912).

Compere, H., *Univ. Calif. Pub. Entom.*, vol. 3, pp. 295–296 (1925).

Essig, E. O., *Insects W. No. Am.*, p. 828 (1926).

Smith, H. S., and Compere, H., *Univ. Calif. Pub. Entom.*, vol. 4, pp. 269–270, figs. 17–18 (1928).

[200] Howard, L. O., *Entom. News*, vol. 21, pp. 162–163 (1910) (*Perissopterus*).

Mercet, R. G., *Los Afelininos*, Trabajos del Museo de Ciencias Nat., no. 10, p. 118 (1912).

[201] Smith, H. S., and Compere, H., *Univ. Calif. Pub. Entom.*, vol. 4, p. 71 (1928).

[202] Compere, H., *Univ. Calif. Pub. Entom.*, vol. 4, pp. 15–18, fig. 6 (1926).

[203] Timberlake, P. H., *Proc. Entom. Soc. Hawaii*, vol. 4, pp. 190, 227–231 (orig. desc.), 238, 242 (1919).

(Sign.). It was described by Timberlake in 1919. It is believed to have been introduced into the islands several years prior to its first discovery. C. P. Clausen reared it from citricola scale, *Coccus pseudomagnoliarum* (Kuw.), at Yokohama, Japan, and forwarded material to California which arrived June 3, 1923, and which yielded seven adults, three of which were liberated on plants infested with the tessellated palm scale on the Huntington Estate near Pasadena, Calif., and the remainder were retained for propagation in the insectary.[204] According to H. Compere this is the insect referred to as "a new species of *Anicetus*, reared from soft brown scale, *Coccus hesperidum* Linn.," in southern California by Timberlake and referred to on p. 294 in his article on a Preliminary Report on the Parasites of *Coccus hesperidum* in California in 1913.[205]

Metaphycus sp. (*Aphycus* sp.). An undetermined species of this genus was reared from citricola scale at Yokohama, Japan, by C. P. Clausen and sent to California, where it was received June 4, 1922. From this material 25 specimens were recovered, but nothing is recorded as to their fate.[206] They were no doubt liberated in orchards infested with the citricola scale.

Metaphycus helvolus (Compere) [207] (*Aphycus*) was reared from an unknown scale at Cape Town, South Africa, by E. W. Rust and received from him by the State Insectary at Riverside, in July, 1924. It reproduced on young black scale in the insectary, which indicates that this scale was probably the original host.

Metaphycus punctipes (Dalman) [208] is apparently a widely distributed species which was described by Dalman in 1820 and found to occur in Europe, where it is parasitic on the brown apricot scale, *Lecanium corni* Bouché, *L. coryli* (Linn.), the plum lecanium, *L. prunastri* (Fonsc.), and the grape pulvinaria, *Pulvinaria vitis* (Linn.). It was reared from the citricola scale at Yokohama, Japan by C. P. Clausen and material sent to California, arrived June 3, 1923. From it four adults issued.[209]

[204] Calif. State Dept. Agr., *Mthly. Bul.*, vol. 12, pp. 336, 337 (1923).
[205] *Jour. Econ. Entom.*, vol. 6, pp. 293–303 (1913).
[206] Calif. State Dept. Agr., *Mthly. Bul.*, vol. 11, p. 829 (1922).
[207] Compere, H., *Univ. Calif. Pub. Entom.*, vol. 4, pp. 25–29, fig. 9 (1926).
[208] Dalman, J. W., *Svensk. Vet.-Akad. Handl.*, vol. 41, p. 154, pl. 8, fig. 60 (1820) (*Encyrtus*).
Timberlake, P. H., *Proc. U. S. Nat. Mus.*, vol. 50, pp. 608, 612 (1916) (*Aphycus*).
Mercet, R. G., *Himenópteros Fam. Encirtidos*, Museo Nat. de Ciencias Nat., pp. 216–218 (1921) (*Metaphycus*).
[209] Calif. State Dept. Agr., *Mthly. Bul.*, vol. 12, p. 336 (1923).

Metaphycus lounsburyi (Howard) [210] (*Aphycus*) is one of the most remarkable and interesting parasites introduced into California. It was described as *Aphycus lounsburyi* by Howard in 1898, from four females reared from black scale at Cape Town, South Africa, by C. P. Lounsbury. It was first taken notice of in California by E. M. Ehrhorn and through Hon. S. F. Leib of San José, Senator Geo. C. Perkins of California was induced to call upon the Secretary of Agriculture, James Wilson, at Washington, D. C., to seek aid in securing from the government of Cape Colony living specimens of *Metaphycus lounsburyi* (How.) and *Scutellista cyanea* Mots. While specimens of the latter were sent to California in 1901 there is no further mention of the former until many years later.

In May, 1912, Carnes reported the receipt of two shipments from Lounsbury which contained twenty-five living adults of *Metaphycus lounsburyi*, but as no further information was given as to their fate, it is probable that they were liberated on black scale, perhaps in a section where there is an even hatch of the black scale and the parasite perished.

The history of the introduction and establishment of this interesting parasite is ably given by Smith and Compere [211] as follows:

In 1913, the senior author, then employed by the California State Commission of Horticulture, wrote to Lounsbury requesting additional shipments of parasitized black scale from the Cape, similar to those previously sent. This request met with a generous response and as a result several shipments were received in California. A few specimens of what was unquestionably *Metaphycus lounsburyi* were reared in 1914 from black scale collected at Wynberg and Sea Point near Cape Town itself. However, the species was not es-

[210] Howard, L. O., *Proc. U. S. Nat. Mus.*, vol. 21, pp. 241, 244 (1898) (*Aphycus*).
Ashmead, W. H., *ibid.*, vol. 22, pp. 323–412 (1900).
Craw, Alex., Calif. State Bd. Hort., *Seventh Bien. Rept.*, 1899–1900, p. 64 (1901).
Schmiedeknecht, O., *Gen. Insectorum*, fasc. 97, p. 240 (1909).
Quayle, H. J., and Rust, E. W., Calif. Agr. Expt. Sta., *Bul. 223*, p. 191 (1911).
Carnes, E. K., Calif. State Hort. Com., *Mthly. Bul.*, vol. 1, p. 398 (1912).
Timberlake, P. H., *Proc. U. S. Nat. Mus.*, vol. 50, pp. 610–612, fig. 24 (1916).
Smith, H. S., and Compere, H., Calif. State Dept. Agr., *Mthly. Bul.*, vol. 9, pp. 310–320, figs. 82–86, frontisp. (1920); *Univ. Calif. Pub. Entom.*, vol. 4, pp. 275–291, figs. 25–29 (1928) (*Metaphycus*).
Smith, H. S., Calif. State Dept. Agr., *Mthly. Bul.*, vol. 10, pp. 127–137, fig. 25, pp. 585–590, fig. 86 (1921); *Jour. Econ. Entom.*, vol. 14, pp. 348–350 (1921); vol. 16, pp. 506–511 (1923).
Compere, H., *Calif. Citrograph*, vol. 6, p. 197 (1921); *Calif. Cultivator*, vol. 59, pp. 29–30 (1922).
Armitage, H. M., Calif. State Dept. Agr., *Mthly. Bul.*, vol. 11, pp. 826–827 (1922); *Jour. Econ. Entom.*, vol. 16, pp. 511–516 (1923).
Essig, E. O., *Insects W. No. Am.*, pp. 834–835, figs. 700–703 (1926).

[211] Smith, H. S., and Compere, H., *Univ. Calif. Pub. Entom.*, vol. 4, pp. 276–279, 289–291 (1928).

tablished in California as a result of these African shipments. E. J. Vosler was sent to Australia as entomological explorer for the California State Commission of Horticulture, primarily for the purpose of collecting parasites for use against the sugarbeet leafhopper. Vosler was advised to be on the lookout for other beneficial insects which might be of possible value in California. On returning from Australia in 1918 he brought a small colony of *Metaphycus lounsburyi* to California in living condition. These were collected in black-scale-infested orchards which he visited at Epping, New South Wales. This colony reproduced at the insectary at Sacramento. When sufficient progeny were obtained a few colonies were placed in several orchards infested with black scale in northern and central California, but it was not until 1919 that this species made its first and greatest success at Santa Paula in southern California.

Laboratory observations made at Sacramento in the spring of 1919 indicated that *Metaphycus lounsburyi* was a very valuable parasite and one that would probably be of considerable influence in reducing the abundance of the black scale in California. With the acquisition of *M. lounsburyi* we then had in our possession a sequence or combination of parasites which were capable of attacking the black scale in all of its various stages. For the purpose of establishing *M. lounsburyi* in southern California, and to demonstrate the possibility of actually controlling the black scale by the utilization of a sequence of its parasitic enemies, it was decided to establish three experimental plots. In the fall of 1919 at the Limoneira Ranch, Santa Paula, California, fifty-three lemon trees heavily infested with black scale were left untreated in order to provide a propagating ground or incubation plot for the natural enemies of the black scale. The work on the Limoneira Ranch was made possible through the coöperation of (C. C.) Teague and (J. D.) Culbertson.[212] Two other plots were selected in the city of Alhambra, one comprising two and one-half acres set to oranges and the other having one hundred trees. The Alhambra plots were also left untreated through the coöperation of their owners, F. Q. Storey and George Patton. Santa Paula and Alhambra were selected because of the differences in climate, the former locality being representative of the coastal region, while the latter possesses a climate somewhat similar to that of the interior valleys. It may be stated that in general the climate of southern California favors the development of the black scale. There are, however, seasons when the climatic conditions are adverse, excessive or prolonged high summer temperatures playing havoc with young scales and eggs. Temperatures of 106° F. or higher frequently prevail in the interior valleys. In most cases when such high temperatures are maintained for several days in succession a high mortality of the scale results, the mortality often being in excess of 90 per cent. The most uniform temperatures occur along the coast, where the weather is nearly always cool and subject to little daily and seasonal change, on account of the modifying influence of the ocean. Towards the interior valley regions, where the ocean winds gradually lose their tempering effect, the temperatures are subject to much greater range and often the summer days become very hot. Santa Paula has a climate very similar to that of Cape Town, South Africa,

[212] S. H. Essig was in charge of the Limoneira insectary.

but not so humid as that of Sydney, New South Wales. Alhambra is much more desert-like, having lower humidity and much greater range of temperature. Santa Paula was selected with the idea that the parasites would find an environment similar to that occurring in their native habitat, while Alhambra would serve to indicate what could be expected from the parasites when confronted by an adverse environment. Santa Paula is representative of the uneven-hatch areas while Alhambra is typically even-hatch.

FIG. 114.—Exit holes of the parasite, *Metaphycus lounsburyi* (Howard), in half-grown black scale. This specimen was taken from the lemon orchards of the Limoneira Company, Santa Paula, May 5, 1921, when the parasite was at the peak of its efficiency in California. Nearly every immature scale was parasitized.

In September, 1919, several strong colonies of *Metaphycus lounsburyi* were carried by automobile from Sacramento to southern California. A stop was made at the Limoneira Ranch, Santa Paula, where the first colonization in southern California was made. Later supplementary liberations were made during the late fall and winter of 1919 and continued during the spring of 1920. In the Santa Paula plot a small number of scales exhibited parasitism by *Metaphycus* as early as the latter part of October, 1919. By May, 1920,[213] this plot was well stocked with *Metaphycus*, the majority of the scales on the original fifty-five trees having been parasitized. By the summer of the following year there was an overflow of parasites to the surrounding trees wherever the scales occurred.

This very creditable showing made by *Metaphycus* led the managers of the Limoneira Ranch to set aside a much greater acreage, which was ultimately extended to include almost the entire ranch. Later, other organizations followed the lead of the Limoneira people, so that in Ventura County during the years 1921 and 1922 many thousands of acres of oranges and lemons were left unfumigated, and reliance placed on the natural enemies to gain a satisfactory control (Fig. 114). In Ventura County local organizations undertook the distribution of *Metaphycus* in coöperation with the Limoneira Ranch

[213] By August, 1920, 30,000 adult parasites had been liberated in southern California.

officials. The California Fruit Growers' Exchange, through its field department, undertook the work of distributing *Metaphycus lounsburyi* to the groves of its members located throughout the black-scale-infested districts of southern California. The work with *Metaphycus* in the Storey and Patton orchards at Alhambra indicated that a satisfactory natural control, comparable to that gained in Ventura County, could not be obtained when the parasites were confronted by an even-hatch condition of the black scale.

During the four seasons, 1920–24, *Metaphycus lounsburyi* was the most abundant and effective of the insect enemies of the black scale in southern California. In certain uneven-hatch areas the black scale was temporarily reduced to such a degree that fumigations were no longer required. Unfortunately, owing to the activities of secondary parasites, the control was not permanent, the secondaries succeeding in reducing the numbers of the primary species so greatly that fumigation was again necessary. Prior to the introduction of *Metaphycus*, the black scale in the uneven-hatch areas could only with difficulty be controlled by one annual fumigation, as a great many of the scales were always of a size which was resistant to the maximum doses of gas that could be used without injury to the trees. In these areas, *Metaphycus* has evened the development of scale to such an extent that, in most cases, one annual fumigation is sufficient to give a commercial control. This has resulted in a great saving. Each year there have been cases reported where *Metaphycus* is credited with bringing about a control.

In our work of introducing new natural enemies of the black scale we are continually confronted with the work of *Metaphycus*. Three or four years ago, uneven-hatch black scale infestations could readily be located at almost any season. Now such infestations free from *Metaphycus* are not so commonly encountered. In the even-hatch areas this parasite is commonly met with in abundance during the summer months, sometimes parasitizing 95 per cent or more of the scales; yet enough young scale hatch to reinfest the trees heavily, and artificial methods of control must be regularly practiced.

Hyperparasites were noted as early as 1921 in California. In 1923 Smith and Compere recorded seventeen hyperparasites associated with *Metaphycus* in various parts of the world, of which nine were demonstrated in the laboratory to attack *M. lounsburyi* (How.).[214] The hyperparasites studied were:

Species Definitely Known to Be Parasitic on *M. lounsburyi* (How.)	Species Supposedly Parasitic on *M. lounsburyi* (How.)
* *Cheiloneurus inimicus* Comp.	* *Cheiloneurus lineascapus* Comp.
* *Eupelmus inyoensis* Gir.	* *Cheiloneurus noxius* Comp.
* *Eusemion californicum* Comp.	*Cheiloneurus obscurus* Silv. (Africa)
Euxanthellus sp. (South Africa)	*Diversinervus elegans* Silv. (Africa)
* *Marietta mexicana* (How.)	*Diversinervus* sp. (Natal, Africa)

* These species only occur in California.

[214] Smith, H. S., and Compere, H., *Univ. Calif. Pub. Entom.*, vol. 4, p. 242 (1928).

Species Definitely Known to Be Parasitic on *M. lounsburyi* (How.)	Species Supposedly Parasitic on *M. lounsburyi* (How.)
* *Quaylea whittieri* (Gir.)	*Euxanthellus subochraceus* (How.) (So. Africa)
* *Thysanus nigra* (Ashm.)	*Tetrastichus* sp. (Natal, Africa)
* *Tetrastichus blepyri* (Ashm.)	
Tetrastichus injuriosus Comp. (So. Africa)	

* These species only occur in California.

In addition to these there are seven parasites associated with black scale and *Metaphycus*, the habits of which remain unknown.

At the present time this parasite is of great value in that it evens up the hatch of the black scale in the coastal regions and permits more effective artificial control.

Metaphycus (*Euaphycus*) *luteolus* (Timberlake) [215] (*Aphycus*) has long been known in California as *Aphycus flavus* Howard. In 1916 Timberlake showed that the true *A. flavus* did not occur in California and gave the name *A. luteolus* to the species previously considered under the name. The specimens described by Timberlake were reared from the soft brown scale at Santa Paula, Aug. 15–28, 1912; Whittier, Apr. 21, 1911; Carpinteria, Sept. 20–22, 1912; Sacramento, Nov. 22, 1912; and specimens reared from black scale at Chula Vista, Sept. 5, 1912; Sweetwater Dam, Sept. 10, 1912; and also two specimens reared from the citricola scale at Claremont, July 10–11, 1912 and 1913. This list gives an idea of the distribution in California. According to Smith and Compere it breeds extensively on all of the three hosts listed above. As all of these hosts are introduced it would appear that the parasite was of foreign origin, but as yet it is not known outside of California. Timberlake has suggested the above arrangement of the genera.

Comperiella bifasciata Howard [216] was described by Howard in

[215] Quayle, H. J., Calif. Agr. Exp. Sta., *Bul. 214*, p. 476, figs. 28–30 (1911) (*Aphycus flavus* Quayle—not Howard).
Quayle, H. J., and Rust, E. W., *ibid.*, *Bul. 223*, pp. 190, 194, figs. 14–18 (1911).
Timberlake, P. H., *Jour. Econ. Entom.*, vol. 6, p. 294 (1913) (*Aphycus* sp. near *flavus*); *Proc. U. S. Nat. Mus.*, vol. 50, pp. 636–637, figs. 28, 45 (1916) (Orig. desc.) (*Aphycus*).
Compere, H., *Bul. So. Calif. Acad. Sci.*, vol. 23, pt. 4, pp. 113, 116 (1924).
Essig, E. O., *Insects W. No. Am.*, p. 835, fig. 704 (1926).
Smith, H. S., and Compere, H., *Univ. Calif. Pub. Entom.*, vol. 4, pp. 274–275 (1928).

[216] Howard, L. O., *Entom. News*, vol. 17, pp. 121–122 (1906); vol. 18, p. 237 (1907).
Timberlake, P. H., *Proc. Ent. Soc. Hawaii*, vol. 4, pp. 185, 190, 193, 194 (1919).
Compere, H., *Univ. Calif. Pub. Entom.*, vol. 4, pp. 44–48, figs. 7–8 (1926).
Smith, H. S., and Compere, H., *ibid.*, pp. 63–71, figs. 1–10 (1927).

1906 from a single female reared from red scale, *Chrysomphalus aurantii* (Mask.), in China. The next year, E. K. Carnes, of the State Insectary at Sacramento, sent Howard a male also from the same source and which was accordingly described the same year. Material bearing this parasite was collected in China by Compere in 1905 and sent to the State Insectary for rearing and colonizing. In 1922 C. P. Clausen found the parasite attacking red scale and Florida red scale, *Chrysomphalus aonidum* (Linn.), at Yokohama, Japan, and sent material to California, which was received July 9, 1922. From this colony 207 adults were reared, thirty of which were liberated on a covered lemon tree infested with red scale on the Bastanchury Ranch near Fullerton and the rest were retained for propagation in the insectary.[217] However, it was found impossible to rear this parasite on the California red scale in confinement and it soon disappeared in the insectary.

In 1924 F. Silvestri sent another lot from China, where he also found it breeding abundantly upon red scale and the Florida red scale. From this lot the parasite was colonized on the Florida red scale at the Huntington Estate near Pasadena and at the Mesick Nursery, Montebello, Calif. However, after many trials it was found by Smith and Compere that the parasite would not propagate in red scale in California. An examination by G. F. Ferris showed no noticeable anatomical difference in this scale as it occurs in California and in China. This peculiarity nullifies the value of the parasite in so far as the red scale, *Crysomphalus aurantii* (Mask.), in California is concerned, but it may prove valuable as a check for the Florida red scale in California.

Encyrtus infelix Embleton [218] is a widely distributed parasite of the hemispherical scale, *Saissetia hemisphærica* (Targ.). Ashmead recorded it from the Hawaiian Islands as *Encyrtus fuscus* (How.) in 1901. In 1918 Timberlake noted it in Hawaii and also from Scotland, England, Portugal, Sychelles Islands, and San Francisco and Sacramento, California. In 1919 he added Fiji, Queensland, Samoa, and the Philippine Islands. In 1921 E. W. Rust collected a supply of this parasite in the Hawaiian Islands and brought it to California. After rearing it in the insectary distributions were made

[217] Calif. State Dept. Agr., *Mthly. Bul.*, vol. 12, pp. 336, 337 (1923).

[218] Timberlake, P. H., *Proc. Entom. Soc. Hawaii*, vol. 3, p. 403 (1918); vol. 4, pp. 183, 187, 194, 195 (1919).

in California[219] as follows: A large colony at the Leffingwell Ranch, Whittier, Dec. 6, 1921, and a small colony at the same place, Nov. 2, 1922; a colony at the Huntington Estate near Pasadena, Dec. 28, 1921; and a colony at Lincoln Park, Los Angeles, Dec. 30, 1921. The species has not been recorded since in this state.

The Sicilian mealybug parasite, *Leptomastidea abnormis* (Girault),[220] according to P. H. Timberlake, was first collected by H. J. Quayle in Sicily in 1913 and specimens were examined by him (Timberlake) in the U. S. National Museum, before the species was introduced into California and before it was described by A. A. Girault. It was collected again at Palermo, Sicily, by H. L. Viereck in June, 1914. The following July and August citrus mealybug, *Pseudococcus citri* (Risso), material was sent to California where the parasite was discovered and propagated at the state insectary at Sacramento by H. S. Smith, and late in 1914, colonies were liberated at Alhambra, San Francisco, Ventura, Marysville, San Diego, Riverside, and Fresno. A colony was also sent to Florida. Adults were first recovered from citrus orchards, infested with the citrus mealybug, at San Diego in November, 1915. So promising was this parasite that the entire breeding stock was moved to a sublaboratory established for this purpose at Pasadena in charge of E. J. Branigan. Although previously discovered at Sacramento, here was further developed in 1916 the method of rearing mealybugs on potato sprouts, which at once permitted of an enormous production of parasites. By 1916 the parasite had become well established in many parts of the state, but colonies were still placed in the field during that year and the next. In Ventura County alone, 25,000 adults were colonized in 1917, and in like numbers in many other counties of southern California. The little

[219] Calif. State Dept. Agr., *Mthly. Bul.*, vol. 11, p. 831 (1922); vol. 12, p. 337 (1923).

[220] Viereck, H. L., Calif. State Hort. Com., *Mthly. Bul.*, vol. 4, pp. 208–211, figs. 36–38 (1915). (*Leptomastix* sp.)

Girault, A. A., *Entom.*, vol. 48, p. 184 (1915) (*Paraleptomastix*) (Orig. desc.).

Smith, H. S., Calif. State Hort. Com., *Mthly. Bul.*, vol. 4, pp. 525–527, 543, fig. 108 (1915); vol. 6, pp. 349–350 (1916); *Jour. Econ. Entom.*, vol. 10, pp. 262–268, figs. 9–13, pls. 13–14 (1917).

Timberlake, P H., *Univ. Calif. Pub. Entom.*, vol. 1, pp. 364–367, fig. 7, B (1918) (*Tanaomastix*).

Smith, H. S., and Armitage, H. M., Calif. State Dept. Agr., *Mthly. Bul.*, vol. 9, pp. 115–118, 119–122, 144–145, fig. 45 (1920).

Essig, E. O., *Insects W. No. Am.*, pp. 836–837 (1926).

Smith, H. S., and Compere, H., *Univ. Calif. Pub. Entom.*, vol. 4, p. 334 (1928) (*Leptomastidea*).

parasite has become thoroughly established in all parts of the state where the host occurs out of doors and has afforded a partial control of the citrus mealybug. It limits its attacks to this particular mealybug and does not control any of the other injurious species in California.

Gyranusa albiclavata (Ashm.)[221] (*Tanaomastix*) was described from a single specimen collected in Hongkong, China. A specimen in the collection of the state insectary reared from *Pseudococcus* sp. in the Philippines was probably sent to California by George Compere. The parasite was apparently never liberated.

Quaylea whittieri (Girault) [222] is the most important and destructive hyperparasite of *Tomocera californica* How., *Scutellista cyanea* Mots., and *Metaphycus lounsburyi* (Howard) in California. It was discovered at Brisbane, Queensland, Australia, by George Compere in 1901. The history of the introduction of this destructive hyperparasite into California has never been adequately stated. The private correspondence between Geo. Compere, in Australia, and Alexander Craw, in California, now in possession of Harold Compere, clearly shows that both suspected it of being a hyperparasite and that neither of them were entirely responsible for the error of its liberation in California. In the meager literature regarding the

[221] Ashmead, W. H., *Proc. U. S. Nat. Mus.*, vol. 29, p. 404 (1905) (*Aphycus*).
Timberlake, P. H., *Univ. Calif. Pub. Entom.*, vol. 1, p. 367 (1918).

[222] *Hemencyrtus crawi* (Ashmead, MSS.).
Craw, A., Calif. State Bd. Hort., *Seventh Bien. Rept.*, 1899–1900, p. 65 (1901); *Eighth Bien. Rept.*, 1901–1902, pp. 196–197 (1902).
Despeissis, A., and Compere, Geo., Dept. Agr. W. Australia, *Bul. 4*, p. 92 (1903).
Despeissis, A., *Jour. Dept. Agr.*, W. Australia, vol. 3, pp. 116–117, 119 (1901); vol. 9, pp. 16–17 (1904).
Isaac, John, Calif. State Hort. Com., *First Bien. Rept.*, 1903–1904, p. 95 (1905).
Silvestri, F., *Hawaii Bd. Agr. and Forestry*, vol. 6, pp. 305–306 (1909).
Berlese, A., Inst. Inter. d'Agr., *Ann. 6*, no. 3, p. 7 (1916).
Cerchysius sp.
Quayle, H. J., and Rust, E. W., Calif. Agr. Exp. Sta., *Bul. 223*, pp. 187–188, fig. 12 (1911).
Timberlake, P. H., *Jour. Econ. Entom.*, vol. 6, p. 301 (1913).
Cerchysius whittieri Girault.
Girault, A. A., *Entom. News*, vol. 29, p. 66 (1918) (Orig. desc.).
Quaylea aliena Timb.
Timberlake, P. H., *Proc. Entom. Soc. Hawaii*, vol. 4, pp. 214–217 (1919).
Quaylea whittieri (Girault).
Ibid., vol. 5, p. 166 (1922).
Smith, H. S., *Jour. Econ. Entom.*, vol. 14, p. 350 (1921); vol. 16, p. 511 (1923).
Compere, H., *Calif. Cultivator*, vol. 59, p. 29 (1922).
Armitage, H. M., *Jour. Econ. Entom.*, vol. 16, p. 513 (1923).
Essig, E. O., *Insects W. No. Am.*, p. 838, fig. 707 (1926).
Smith, H. S., and Compere, H., *Univ. Calif. Pub. Entom.*, vol. 4, pp. 292–295, figs. 30–31 (1928).

affair three parasites appear to be confused. The parasite collected on black scale at Brisbane, Queensland, Australia, and the one which enthused Compere most, appears now to be *Metaphycus lounsburyi* (How.), referred to in Compere's correspondence as "the parasite of the half-grown black scale." It was a great disappointment to both Compere and Craw that Compere was recalled to California before this parasite could be introduced. In Brisbane Compere also collected and sent to Craw the black scale parasites, *Myiocneme comperei* Ashm., in May and July, 1900, and *Tomocera californica* How. in 1900 and 1901. Associated with these parasites was a species designated as "a small slender one" which was suspected of being a secondary by both Compere and Craw. "In fact Craw refused to liberate it at first. Subsequently he was informed that the species was undescribed and had been given the manuscript name *Hemencyrtus crawi* by Ashmead. Later, for some reason not made clear in the correspondence, Craw's suspicion regarding the host relationship of this parasite was allayed and he regarded it as a primary parasite. He colonized it and requested Compere to send more living specimens."

After receiving this apparently adequate advice from Craw, Compere sent the insect into western Australia in 1901 and began forwarding material to California in the same year.

The material sent to California was accordingly colonized by Alex. Craw, who, not being skilled in the determination of parasites, was compelled to rely entirely upon the determinations made by specialists, a practice which could not be otherwise in those days. Specimens sent to Ashmead in 1901 were determined as a new species, *Hemencyrtus crawi*, but this name became invalid because the description was never published. However, the early records of this insect both in Western Australia and California refer to it by this name. Shipments arrived in California in 1901, were placed in cages and colonies reared and distributed by Craw as follows: 10 colonies in Santa Clara County, 7 colonies in Los Angeles County, 2 colonies in Santa Barbara County, 2 colonies in Alameda County, 2 colonies in Ventura County, 1 colony in San Diego County, and 1 colony in Monterey County. Thus this enemy of *Tomocera californica* How., which was introduced at the same time, was well distributed and at once established itself, particularly in southern California.

After its introduction no further notice was given this insect

until Quayle and Rust discovered it to be parasitic upon the larvæ of *Scutellista cyanea* Mots. at Whittier, Glendale, Pomona, Santa Paula, and Santa Barbara. They figured it and referred to it as *Cerchysius* sp. (Fig. 115), the name under which it was originally introduced having been long forgotten.

In 1918 A. A. Girault found specimens of the species in the collection of the U. S. National Museum—undoubtedly specimens

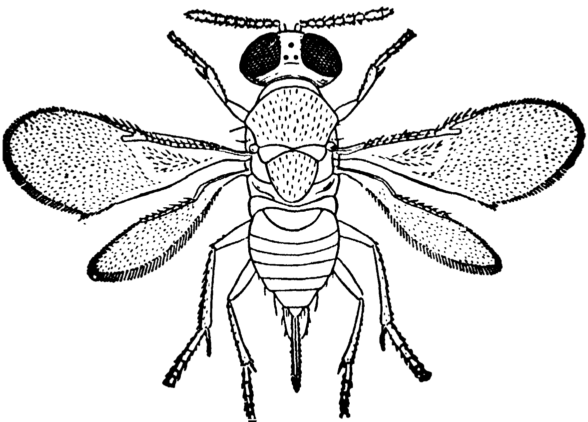

Fig. 115.—The destructive hyperparasite, *Quaylea whittieri* (Girault), as figured by H. J. Quayle in 1911, under the name *Cerchysius* sp.

received from Craw, and he described it as a new species, *Cerchysius whittieri.*[223] The same insect reared from scutellista and parasites of *Asterolecanium* sp., *A. pustulans* (Ckll.), and *Coccus viridis* (Green), in Hawaii, by Timberlake, was described in a new genus and a new species, *Quaylea aliena* by him in 1919. In 1919 Timberlake recognized the synonymy of the species and referred it to the new genus *Quaylea* by which name it is now known.

Following the introduction of *Metaphycus lounsburyi* (Howard) into California in 1918 and its establishment and phenomenal increase during .1920–1922, this hyperparasite, *Quaylea whittieri* (Girault), came into its own and increased at the expense of the parasite until the work of the latter was practically nullified, after which both began to decline in numbers until a more or less stable equilibrium had been reached, whereby the efficiency of the parasites of the black scale, introduced with such infinite labor and

[223] According to Timberlake this species was named for the poet, J. G. Whittier and not for the city of Whittier in southern California.

expense, has been greatly reduced in the commercial control of the black scale in California.[224]

In 1921 E. W. Rust encountered this hyperparasite which was included in a shipment of black scale from Sydney, Australia, to California, but which was of course destroyed at the state insectary.

The story of the introduction of this hyperparasite into western Australia and California furnishes a most remarkable example of the importance of intrusting all of the introduction of foreign insects only in the hands of the very best trained and most experienced professional men. Such mistakes cannot be corrected, but they can be avoided in the future.

Oriental mealybug parasite, *Pauridia peregrina* Timberlake,[225] is a mealybug parasite of *Pseudococcus krauhniæ* (Kuwana). According to Timberlake it may have been introduced into Hawaii years ago possibly from China by George Compere about 1908. It is known to occur at Amoy in China, Fiji, Manila, Japan, and many parts of Hawaii. Smith reports the colonization of it on *P. krauhniæ* (Kuw.) in the Ojai Valley, Ventura County, California, in 1919, from material which originally came from Honolulu through Timberlake in 1916, and which was maintained in the branch insectary at Alhambra on *Pseudococcus maritimus* (Ehrh.).

Tetracnemus prætiosus Timberlake [226] was reared from *Pseudococcus gahani* Green, collected at Sydney, New South Wales, Australia, in January, February, and March, 1928, by Harold Compere. It was brought back to California by Compere in March, 1928, and reared at Riverside and distributed in southern California as a parasite of the above mentioned mealybug. It has become permanently established. In 1928–1929 the Orange County Insectary liberated great numbers of this parasite in Orange County.[227] In the spring of 1930 great numbers of dead carcasses of mealybugs

[224] H. Compere calls attention to the fact that the two other hyperparasites, *Tetrastichus blepyri* Ashm. and *Eusemion californicum* Compere, both of which appear to be native species, are almost as serious as *Quaylea*. He states: "In recent years these two hyperparasites have been reared more often and in greater numbers than *Quaylea*. If *Quaylea* does not destroy *Metaphycus* first, they will do so."

[225] Timberlake, P. H., *Proc. Entom. Soc. Hawaii*, vol. 4, pp. 186, 193, 194, 195, 208 (Orig. desc.) (1919), p. 609 (1920).

Fullaway, D. T., *ibid.*, pp. 238, 240 (1920).

Calif. State Dept. Agr., *Mthly. Bul.*, vol. 9, p. 446 (1920).

[226] Timberlake, P. H., *Univ. Calif. Pub. in Entom.*, vol. 5, pp. 5–11, figs. 1–2 (1929).

[227] Brock, A. A., Calif. State Dept. Agr., *Mthly. Bul.*, vol. 18, p. 516 (1929).

found under burlap bands in Los Angeles County, testified to the very good work of this parasite.

It was later described by Timberlake in 1929, as were also two other encyrtid parasites, *Anusoidea comperei* Timb.[228] and *Anarhopus sydneyensis* Timb.,[229] reared from the same host at Sydney, New South Wales, Australia, in 1927 and 1928.

Foreign Collectors [230]

Next to a thoroughly trained staff and a completely equipped insectary for studying and rearing beneficial insects, are the foreign collectors whose duties are largely those of discovery and carrying out the plans of the insectary staff. They are sent to foreign countries, usually with a specific mission, but they must always be on the lookout for new and promising predacious and parasitic insects. F. Silvestri has given the following advice [231] to such collectors:

1. Know the native home of the injurious pests for which natural enemies are desired. This is often very difficult and complicated.
2. Visit as many localities as possible in which the pest is native.
3. Collect as much material, including all stages of the beneficial insects desired in these different localities as is obtainable.
4. Collect the material over a long period of time, at least six or seven months or better a full year in order to secure as great a variety and quantity as is available.
5. From accurate observations and experiments, if possible, choose the most promising natural enemies available in the different localities.
6. Study the biology of the natural enemies and distinguish between primary and secondary parasites.
7. Eliminate all possibilities of introducing secondary parasites and other injurious insects.
8. Study methods of transporting the beneficial insects and provide sufficient food en route.
9. Introduce as many parasites and predators as possible.
10. Expect to contract and endure diseases and hardships often with poor accommodations.
11. Work all of the time to take care of the beneficial insects collected.
12. Surmount every difficulty.
13. Have confidence in and a real love for the work.

[228] Timberlake, P. H., *ibid.*, pp. 11–15, figs. 3–4 (1929).
[229] Timberlake, P. H., *ibid.*, pp. 15–18, fig. 5 (1929).
[230] The author is indebted to H. S. Smith and H. Compere for reading and making a number of corrections and additions to this portion of the manuscript.
[231] In a speech delivered to the University of California Entomology Club, Berkeley, Calif., Sept. 11, 1928.
Also see article by H. S. Smith, *The entomological explorer*, Calif. Hort. Com., Mthly. Bul., vol. 6, pp. 55–56 (1917).

With these and many other ideas in mind field collectors have spelled success or failure for biological control work everywhere.

In weighing the value of the accomplishments of the foreign collectors in connection with the introduction and establishing of beneficial insects one must not overlook the proper assignment of credit to those who are responsible for the direction of the work and for receiving, rearing, studying, and liberating the beneficial ones and eliminating the destructive ones. In connection with the early introductions of A. Kœbele, it was C. V. Riley, who made all of the preliminary studies of the host and possible parasites, selected the collector, secured the necessary funds, and provided for the care of the material when it arrived. D. W. Coquillett in California received the material, supplied food and facilities for rearing and breeding, guarded against undesirable predators and parasites and was in general responsible for the entire work of establishing the insects collected by Kœbele.

In the reorganization of the insectary work in California by H. S. Smith the same principles must be accepted. The conception and direction of the program of work of the collector, involving thorough knowledge of the natural distribution of the pests; the ecological factors and the probabilities of success; the proper packing, transportation and the seasonal delivery of the material; the receipt and care of the original sendings of valuable insects; the complete study of the life histories and habits of the parasites and predators as well as those of the injurious secondaries or hyperparasites; the absolute elimination of every possible secondary or hyperparasite; the determining of the methods of mass production of the beneficial species; and the final liberation and checks in the field require education, experience, skill, and good judgment of such quality as to cast out any doubts regarding the importance of the insectary superintendent and his corps of technical assistants. Such views are in marked contrast to those of the foreign collectors of the time of George Compere, who made little or no important studies of the insects in the field, but who merely collected and shipped the infested host material, without regard or worry as to just what it included. The responsibilities of this important work have been ably carried on by Smith and he has won the confidence of the fruit growers and scientists alike in the biological control program in California.

Albert Kœbele (Figs. 116, 117, 201, 210) (see biographical account, Chapter IX) holds the honor of being the first of these hardy pioneers. He was employed by C. V. Riley for the Division of Entomology, U. S. Department of Agriculture, to collect the natural enemies of the cottony cushion scale in its native home, Australia, and was particularly instructed to secure the dipterous parasite, referred to in correspondence from Frazer S. Crawford of Adelaide, South Australia. Accordingly Kœbele left San Francisco on August 25, 1888, and arrived at Auckland, New Zealand, on September 14th, and at Sydney on September 20th of the same year. His trip proved entirely successful and he sent to California, not only the parasite, *Cryptochætum iceryæ* (Williston), but an entirely unknown predator, the vedalia, *Rodolia cardinalis* (Muls.), which proved to be much more effective in controlling the cottony cushion scale than the dipterous parasite. He also sent over a number of insects of lesser importance including the coccid-eating moth, *Eublemma cocciphaga* (Meyrick), which, however, never became established in the state. Upon his return to California in March, 1889, he was received with great acclaim and arrangements were soon made whereby he was to return to Australia under the joint supervision of the Division of Entomology, which paid his salary, and the California State Board of Horticulture, which appropriated $5000 for traveling expenses. Accordingly he sailed from San Francisco on August 11, 1891, and after spending ten days in Honolulu arrived in New Zealand on

FIG. 116.—Albert Kœbele as he appeared during his later connections with the Hawaiian Sugar Planters' Experiment Station. (After L. O. Howard, 1925.)

September 10, 1891, where four weeks were spent in the search of suitable beneficial insects. Here he also liberated three native species of California ladybird beetles which he had taken along with him. The few things he collected there were forwarded to

FIG. 117.—The little house at 1226 Regent Street, Alameda, California, which was the home of the Kœbeles for many years after their arrival in 1885. On the trees and shrubs of this property were liberated many of the beneficial insects collected in Australia. The house stood unaltered up to the time the author took this picture on November 30, 1927.

California and he left for Australia on October 9, 1891. Most of the following seven weeks were spent in New South Wales where he collected and forwarded to California the mealybug destroyer, *Cryptolæmus montrousieri* Muls., the black ladybird beetle, *Rhizobius ventralis* (Er.), the Australasia ladybird beetle, *Orcus australasiæ* (Bdv.), the steel-blue ladybird beetle, *O. chalybeus* (Bdv.), Kœbele's ladybird, *Novius kœbelei* (Olliff), a great many other ladybird beetles which proved to be of no importance, and the coccid-eating moth, *Eublemma cocciphaga* (Meyrick), which likewise was not successful. He also spent two months in New Cale-

donia and the Fiji Islands, where nothing of importance was secured. He returned to California on August 5, 1892, and resumed his work for the Division of Entomology. In 1893 he severed his connections with this organization and entered the services of the Hawaiian government.

The insects listed in tables on pp. 367–371 were collected by Kœbele and sent to California.[232]

Many of these insects were secured only in small numbers and there were severe losses resulting from the long ocean voyage. Of those which at first gave promise of great value only a few actually became permanently established in California. In reviewing the situation on September 10, 1892, Alexander Craw[233] reported favorably upon *Orcus chalybeus* (Bdv.), *Orcus australasiæ* (Bdv.), *Rhizobius ventralis* (Er.), *Scymnodes* sp., and *Novius kœbelei* (Olliff). (In addition to the vedalia and *Cryptochætum.*) In the early summer of 1894 Craw again visited a number of the localities where these beneficial insects were liberated and found that the following[234] were increasing and working well: *Rhizobius ventralis* (Er.), *R. debilis* Blackb., *Novius kœbelei* (Olliff), *Rodolia cardinalis* (Muls.), and *Orcus chalybeus* (Bdv.).

In 1899 George Compere (Figs. 118, 174) was employed as foreign collector by the California State Board of Horticulture. He sailed for Australia July 21, 1899, and stopped at Hawaii and also visited the adjacent islands and China, where he collected a number of interesting parasites which were sent to California. Among these were supposed parasites of the black scale, including *Tomocera californica* How.; *Hemencyrtus crawi* (Ashm. MSS.), which later proved to be the destructive secondary parasite, *Quaylea whittieri* (Girault); and the supposed parasite of half-grown black scale, *Myiocnema comperei* Ashm., all of which were collected in Australia as were also the dipterous parasite of grasshoppers, *Locustivora pachytyli* (Skuse) (*Masicera*)[235] and the lesser

[232] Kœbele, A., *Report on the importation of parasites and predaceous insects by the State Board of Horticulture*, Calif. State Bd. Hort., pp. 7–12, 1 col. pl. (1892); *Studies of parasitic and predaceous insects in New Zealand, Australia and adjacent islands*, U. S. Dept. Agr., 39 pp. (1893); Calif. State Bd. Hort., *Fourth Rept.*, 1893–1894, pp. 4–7 (1894).

Coquillett, D. W., U. S. Dept. Agr., Div. Entom., *Bul. 30*, pp. 9–26 (1893).

[233] *Rept. on the importation of parasites and predaceous insects by the State Board of Horticulture*, Calif. State Bd. Hort., pp. 13–15 (1892).

[234] Calif. State Bd. Hort., *Fourth Rept.*, 1893–1894, p. 437 (1894).

[235] According to Aldrich this fly appears to be identical with *Sarcophaga opifera* Coq., which was first reared from grasshoppers at Natoma, California, in 1885. If so it is also a native insect.

COCCINELLIDÆ

NAME OF SPECIES	WHERE COLLECTED	NATIVE HOSTS	WHERE INTRODUCED INTO CALIFORNIA	TO CONTROL	YEAR INTRODUCED
Rhizobius aurantii Blackb.	Australia	Red scale and other coccids	Los Angeles	Red scale	1892
R. cæcus Blackb.	"	All coccids	So. California	All coccids	"
R. debilis Blackb.	"	"	"	"	"
R. dorsalis Blackb.	"	Unarmored coccids	Santa Barbara and So. California	Black scale	"
R. fugax Blackb.	"	"	Los Angeles	Soft coccids	"
R. pulcher Blackb.	"	All coccids	So. California	All coccids	"
R. satellus Blackb.	"	Red scale	Los Angeles and So. California	Red scale	"
R. speculifer Blackb.	"	Armored coccids	California	Armored coccids	"
* *R. toowoombæ* Blackb.†	"	Red scale	"	Red scale	"
* *R. ventralis* Er.	"	Unarmored scales	Santa Barbara and So. California	Black scale and other unarmored coccids	"
Scymnus australasiæ Blackb.	"	Armored and unarmored scales	So. California	Red scale	"
S. flavifrons Blackb.	"	"	"	All scales	"
S. notescens Blackb.	"	Aphis	"	Aphis	"

* Became permanently established in California. †This species is a synonym of *Lindorus lophanthæ* (Blaisdell).

COCCINELLIDÆ—*Continued*

NAME OF SPECIES	WHERE COLLECTED	NATIVE HOSTS	WHERE INTRODUCED INTO CALIFORNIA	TO CONTROL	YEAR INTRODUCED
S. sydneyensis Blackb.	Australia	Aphis and unarmored scales	So. California	Aphis and unarmored scales	1892
S. whittonensis Blackb.	"	Armored scales	"	Armored scales	"
Leis conformis Bdv.	Tasmania	Scales and aphis	Santa Barbara and Los Angeles Co.	Unarmored scales, aphis	"
L. antipodum (White)	New Zealand	Soft scales	So. California	Soft scales	1891
Midus pygmæus Blackb.	Australia	Mealybugs	"	Mealybugs	1892
Lipernes subviridis Blackb.	"	Armored scales	"	Armored scales	"
Verania frenata (Er.)	"	Woolly apple aphis and cabbage aphis	"	Aphis	"
V. lineola Fabr.	"	Aphis	"	"	"
Neda testudinaria Muls.	"	"	"	"	"
Halzia galbula Muls.	"	"	"	"	"
Olla abdominalis (Say)	Hawaii. It is indigenous to North America and probably to California	"	San Mateo Co.	"	1891 "
Coccinella arcuata Fabr.	Australia, Fiji	*Lecanium* spp. *Aleyrodes* spp.	Southern California	Soft scales and white fly nymphs	1892
C. kingi Mac Leay	Australia	Aphis, leafhoppers, psyllids, scales	"	Homoptera	"

COCCINELLIDÆ—*Continued*

NAME OF SPECIES	WHERE COLLECTED	NATIVE HOSTS	WHERE INTRODUCED INTO CALIFORNIA	TO CONTROL	YEAR INTRODUCED
C. repanda Thunb.	Australia, Fiji, New Caledonia	Aphis	Southern California	Aphis	1892
C. novazealandica Colenso	New Zealand	Cabbage aphis	"	Cabbage aphis	1889
Alesia frenata (Er.)	See *Verania frenata* wrongly spelled *A. fromata*				
Gymnoscymnus 4-maculatus Blackb.	Australia		Southern California		1892
* *Rodolia cardinalis* (Muls.)	Australia, New Zealand	*Monophlebus fuscus* Mask., *Icerya purchasi* Mask.	"	Cottony cushion scale	"
* *Novius kœbelei* (Olliff)	Australia	"	"	"	"
N. bellus Blackb.	"	"	"	"	"
* *Cryptolæmus montrousieri* Muls.	"	Mealybugs	"	Mealybugs	"
Orcus australasiæ (Bdv.)	"	All scales	"	Scales	"
O. bilunulatus (Bdv.)	"	*Eriococcus* spp.	"	Unarmored scales	"
* *O. chalybeus* (Bdv.)	"	All scales	Santa Barbara and Southern California	Soft scales and black scale	"
O. nummeralis (Bdv.)	"	Soft scales	"	Soft scales and black scale	"
Cycloscymnus minutus Blackb.	"	*Eriococcus* spp.	Southern California	Soft scales	"

* Became permanently established in California.

COCCINELLIDÆ—*Continued*

Name of Species	Where Collected	Native Hosts	Where Introduced into California	To Control	Year Introduced
Cyrema nigellum Blackb.	Australia	*Lecanium* spp.	So. California	Soft scales	1892
Serangium hirtuosum Blackb.	"	Red and black scales	" "	Red and black scales	"
S. maculigerum Blackb.	"	Red scale	"	Red scale	"
Erithionyx lanosus Blackb.	"	*Chionaspis* sp.	"	Armored scales	"

LEPIDOPTERA

Name of Species	Where Collected	Native Hosts	Where Introduced into California	To Control	Year Introduced
Eublemma cocciphaga (Meyr.)	Australia	Unarmored scales	Southern California	Unarmored scales	1892
Tineid larva	"	Armored scales	Central California	San José scale	"

HYMENOPTERA

Name of Species	Where Collected	Native Hosts	Where Introduced into California	To Control	Year Introduced
Ophelosia crawfordi Riley	Australia	Cottony cushion scale	Southern California	Cottony cushion scale	1901

DIPTERA

Name of Species	Where Collectel	Native Hosts	Where Introduced into California	To Control	Year Introduced
Cryptochætum iceryæ (Skuse)	Australia	*Monophlebus fuscus* Mask., *Eriococcus eucalypti* Mask.	Southern California	Cottony cushion scale	1892

NEUROPTERA

Name of Species	Where Collected	Native Hosts	Where Introduced into California	To Control	Year Introduced
Chrysopa sp.	Australia	Various insects	Southern California	Various insects	1889

housefly, *Fannia canicularis* (Linn.) (*Homalomyia*), a scavenger supposed to be parasitic on grasshoppers. The flies were liberated in the Livermore Valley by Craw. From China he introduced what appeared to be a very promising parasite of the red scale which was afterwards named *Comperiella bifasciata* by Howard.[236]

FIG. 118.—George Compere, foreign insect collector for California and Western Australia, as he appeared in China in 1908. (Photograph furnished by Harold Compere.)

At Sydney, Australia, on August 21, 1899, he also noted the work of the Mediterranean fruit fly, *Ceratitis capitata* (Wied.), where he found oranges seriously infested. In Fiji, where he arrived October 15, 1899, he discovered two fruit flies, *Dacus xanthodes* Brown and possibly *D. curvipennis* Froggatt.[237] He again notified Craw regarding the danger of introducing these serious fruit pests into California.[238] Without obtaining anything of value there he returned to Australia, by way of New Zealand arriving at Queensland on December 29, 1899, and began to look for fruit flies. Here he particularly noted the work of the Mediterranean fruit fly and the Queensland fruit fly, *Dacus tryoni* Froggatt, and probably of other species then undescribed.[239] From January until August, 1900, he searched

[236] Craw, Alex., Calif. State Bd. Hort., *Eighth Bien. Rept.*, 1901–1902, p. 192 (1902).

[237] Bezzi, M., *Fruit flies of the genus* Dacus *sensu Latiore (Diptera) from the Philippine Islands*, Philip. Jour. Sci., vol. 15, pp. 411–443, 2 pls. (1919).

[238] Calif. State Hort. Com., *Mthly. Bul.*, vol. 1, pp. 711–712 (1912).

[239] Tryon, H., *Queensland fruit flies*, Proc. Royal Soc. Queensland, vol. 38, pp. 176–224, 5 pls. (1927).

the orchards of New South Wales, Victoria, South Australia, and Tasmania for fruit flies and found no traces in the last three states. He also collected black scale parasites in Queensland, which were sent to Western Australia and California. On August 6, 1900, he left Australia for China, stopping at Ceylon, Java, Singapore, and Saigon and arriving at Hongkong, September 30, 1900. The Boxer uprising prevented inland explorations. Here he discovered a parasite of the red scale and ventured into the country in order to find a suitable small orange tree infested with the scale to send to California. It arrived in good condition at San Francisco, November 21, 1900, and was immediately placed in a glass cage to rear the parasites.[240] From it 647 adult parasites were reared and liberated in citrus orchards infested with red scale in Los Angeles and Orange counties. According to H. S. Smith this parasite is one of the species of *Casca* either *chinensis* Howard, or *smithi* Silvestri (MSS.), both of which attack the red scale in China. It never became established in California. He returned to Australia via Manila and Thursday Island and arrived at Sydney, November 14, 1900. Here he remained until May 10, 1901,[241] when due to the death of B. M. Lelong,[242] Secretary of the California State Board of Horticulture, and a lack of funds for further explorations, he was recalled to Sacramento and arrived in California, June 1, 1901.[243] Before leaving Australia, however, he shipped to California two lots of the small black ladybird beetle, *Stethorus vagans* (Blackb.),[244] a natural enemy of orchard red spiders. These arrived at San Francisco on February 10 and March 18, 1901, respectively. This beetle has done very good work in southern California. After a short stay at Sacramento he accepted a position with the Western Australian government where he began work in September, 1901. For nine months he studied the local conditions and in March, 1902, set out to find parasites for the black scale in New South Wales and Queensland, some of which were sent to California. He returned to Perth to prepare for a trip to collect fruit fly [245] parasites.

[240] Calif. State Bd. Hort., *Eighth Bien. Rept.*, 1901–1902, p. 192 (1902).

[241] He was recalled on April 8th and sailed on May 10th.

[242] B. M. Lelong committed suicide in the Capitol Park, Sacramento, on May 3, 1901.

[243] Compere's correspondence gives the date, May 20, 1901.

[244] The exact identity of the beetle brought over by Compere appears to be obscure.

[245] A real effort had been made in 1901 to exterminate the Mediterranean fruit

On October 2, 1902, he left Perth for New South Wales, not knowing where to seek the desired fruit fly parasites. He sailed for Manila on November 6, 1902, but finding an outbreak of cholera there he did not land but proceeded to Hongkong, where eighteen days were spent at Canton, Amoy, and Hongkong. Next he went to Japan, where winter prevented further field work so he sailed for the United States, arriving at San Francisco, January 20, 1903. His long experience with fruit flies led him to sound an alarm to the fruit growers of California and to state that the accidental introduction of the Mediterranean or the Queensland fruit fly would wipe out the fruit industries of the state.[246] He then went to Washington, D. C., to consult with L. O. Howard and D. W. Coquillett as to the native home of the Mediterranean fruit fly in order to search for the expected natural enemies there. Among other places he learned of its reported occurrence in São Paulo, Brazil, and on March 9, 1903, addressed a letter to H. von Ihering relative to the matter and sailed for southern Europe. He arrived at Barcelona, Spain, March 28, 1903, and an inspection of the olive orchards showed the ravages of the olive fly, *Daucus oleæ* Gmelin. The Mediterranean fruit fly was noted in Valencia Province and at Malaga as well as in Italy. At Portici he visited the celebrated dipterologist, Antonio Berlese, who informed him that it was useless to look for parasites of the fruit fly there, because the insect was a very serious pest in Italy, indicating the absence of any important natural enemies.[247] After collecting a number of beneficial insects he returned to Western Australia, arriving at Fremantle, June 11, 1903. He immediately prepared to visit southern Asia and sailed for India, September 14, 1903, and landed at Bombay, September 28th. He later visited Poona, Nagpur, and Calcutta (October 10, 1903). At Calcutta he received a letter from von Ihering confirming the presence of the Mediterranean fruit fly at

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fly in Western Australia by picking all of the green fruits and boiling them, but this herculean task proved a failure and the fruit fly was even more serious in 1902.

[246] *San Francisco Chronicle*, January 23, 1903.

[247] The insects collected in southern Europe by Compere and forwarded to Western Australia included: "An assortment of coccinellids and parasitized angoumois grain moths were included in a shipment from Valencia, Spain, on April 8. From Barcelona, Spain, he made a shipment of assorted coccinellids on March 30. A large shipment was sent from Marseilles, April 24. This included a number of coccinellids collected at Seville feeding on diaspidine scales; a coccinellid feeding on mealybugs from Malaga; three species of aphis-feeding ladybirds collected at Malaga and Seville; a species of syrphid fly feeding on aphis collected at Malaga; a coccinellid feeding on a red mite at Marseilles; parasitized peach scale, *Lecanium persicæ* (Fabr.)." (From correspondence furnished by Harold Compere.)

São Paulo, Brazil, and also the presence of two other species. He continued to Madras (October 18) and thence to Ceylon where four days were spent at Colombo. In all he had noted some twenty different species of fruit flies, but did not find the Mediterranean fruit fly among them. He landed at Perth November 12, 1903, and left for Brazil via Sydney, January 7, 1904. He arrived at San Francisco, February 22, 1904, and again warned California concerning the seriousness of the Mediterranean fruit fly in particular.[248] While in California he entered into an agreement with Ellwood Cooper, State Commissioner of Horticulture, whereby he would enter the joint services of the state of Western Australia and the state of California, each to bear half of his salary of $200 per month and traveling expenses and to share the benefits of his work.[249]

Compere reached São Paulo, Brazil, April 26, 1904, and visited the surrounding country. Here he reared seven species of fruit flies and some natural enemies including a braconid parasite and a staphylinid predator. He next went to Bahia where all of the fruit flies observed at São Paulo were found as well as several additional species. None of them appeared to be serious pests which led Compere to believe that the natural enemies which he had previously noted at São Paulo and which were present at Bahia were responsible for the condition. He at once began to collect these natural enemies. The difficulties in getting them to Australia are expressed in his own words:[250]

> There were several very serious and difficult problems in connection with my mission which I had to first overcome before any parasites of the fruit flies of Brazil could be landed in Western Australia. The first was the long distance between the two countries which required forty-six days continuous travel by the fastest mail lines; then the great danger there might be in introducing other species of fruit flies into Western Australia; also, to obtain enough of the parasitized pupæ of the fruit flies to make it worth while making the trip, and to secure a sufficient amount of fresh maggots on which to feed the staphylinid beetles during the long journey. There was also to be taken into consideration even if I succeeded in landing my material in good condition in Western Australia, what would the conditions be in the latter place when I arrived, which I had figured would be about the middle of July. This was the middle of winter there and no fruit fly maggots would be present.
>
> To obtain material from which to secure the braconid parasites I covered a

[248] *Calif. Fruit Grower*, February 27 (1904).
[249] *Jour. Dept. Agr.*, W. Australia, vol. 9, pp. 352–353 (1904).
[250] Calif. State Hort. Com., *Mthly. Bul.*, vol. 1, pp. 728–729 (1912).

Pitanga tree on which the fruit was beginning to ripen and captured as many fruit flies on the wing as possible and liberated them under the cover, several specimens of *Ceratitis capitata* being among them. Some of the flies did not take kindly to their imprisonment and flew to the sides of the cloth while others began at once to attack the fruit. The cover was allowed to remain on the tree for five days when it was removed and the maggot-infested fruits exposed to the parasites. Two days after the cover had been removed dozens of parasites could be noticed working among the infested fruits. The tenth day after covering, all fruit was picked off and placed in boxes, and on the eleventh day I sailed from Bahia for Southampton on the steamer *Nile* (now plying between San Francisco and Hongkong). I kept the infested fruits in a cool place until all the maggots had fully developed, when the pupæ were placed in the cool chamber of the ship where I allowed them to remain during the remainder of the voyage.

With the staphylinid beetles (*Huamerocera brasiliensis*) I had a very different problem to solve—how to get them alive to Western Australia. To collect too many of the beetles would require an immense amount of maggots to feed them during the long journey and to place them in the cool chamber of the ship, risked a possibility of their not surviving the journey. The plan which I decided on was to place some in the cool chamber with food, some without any food, and to take one lot in my cabin and feed them on blowfly maggots during the voyage. July 12th I arrived at Perth, Western Australia. The voyage occupied just forty-six days. During the journey I purchased from Peek & Sons, Gray's Inn, London, England, two gallons of blowfly maggots, or gentles, as they are called there, where it is the custom to use them for fish bait. The staphylinid beetles which I had kept in my cabin and fed every day on blowfly maggots, survived the journey in splendid condition with some young larvæ of these beetles also reared on the journey.

Of the two hundred and fifty fruit fly pupæ which had been in the cool chamber, two hundred were found to be parasitized and fifty contained fruit flies, which were at once destroyed. The parasitized pupæ were mostly all placed again in the Government cold storage chambers at Perth to retard development until such time as there would be fruit fly maggots to turn them loose on, while the staphylinid beetles were at once liberated. But there were no fruit fly maggots at that time in the orchards, it being mid-winter, and the chances of their establishing themselves were very slight. However, I had the satisfaction of knowing that it was possible to land these beneficial insects alive in Western Australia.

About August, 1904, he left Australia to search for the codling moth parasite in Spain and took the opportunity to visit the Mediterranean region in order to investigate the fruit fly situation there. Accordingly he visited Port Said, Beirut, Jaffa, Jerusalem, Alexandria, and Malta and found the Mediterranean fruit fly abundant and a serious pest of fresh fruits of all kinds. He also noted the olive fly at Jerusalem and *Dacus longistylus* Wied., at Alexandria. From September 1, 1904, to January 1, 1905, he collected the codling

moth parasite, *Calliephialtes messor* (Grav.), which was sent to California. This interesting ichneumonid fly was reared in great numbers in confinement, but never became a factor in the control of the codling moth after liberation in the orchards.

When he reached San Francisco, January 29, 1905, he was informed by Ellwood Cooper that the natural enemies of the fruit flies collected in Brazil had perished during the winter in Western Australia and instructed him to proceed to Brazil to take back another lot.

He again arrived at Bahia on March 19, 1905, where he remained about twelve days. Here he met C. P. Lounsbury and Claude Fuller of the Cape of Good Hope, who had searched for the same natural enemies, but without success. This time Compere confined his attentions to the staphylinid beetle and found it present in great numbers. Taking several hundred adults and a large number of larvæ, and fruit fly maggots and fresh meat for food, he sailed on the steamer *Thames* April 1st. "Each box of maggoty fruit was placed in an empty flour sack and hung up, and twice each day I collected the maggots which had matured and left it. Some of these maggots were fed to the beetles each day and some placed in the cool chambers of the ship to be used when fresh maggots could not be procured. At Teneriffe I secured a few fresh maggots from oranges, and at Lisbon I was able to obtain quite a lot of fresh maggots belonging to the family Drosophilidæ. Reaching London I obtained a good supply of blowfly maggots and on reaching Port Said secured *Ceratitis capitata* maggots in large numbers from fruits offered for sale at the local fruit stands. At Colombo I was able to obtain a small quantity of the larvæ of *Dacus cucurbitæ* (*Bactrocera*).

"On May 25th I arrived at Perth, Western Australia, fifty-five days after leaving Bahia, with a little over one hundred of the Staphylinid beetles collected at Bahia yet alive, and also a large number reared from larvæ on the journey."[251]

The beetles were reared in confinement on the maggots of *Drosophila* and when they were turned over to an assistant on July 6, there were over a thousand larvæ in addition to the original adults still alive and awaiting proper field conditions for liberation. Through negligence on the part of the assistant the beetles were not properly cared for and the few that were finally liberated perished.

[251] *Ibid.*, p. 845 (1912).

In the meantime Compere had sailed on July 6, 1905, to collect scale parasites in China. He arrived at Hongkong on August 26th and penetrated into the back country, but learning of the perilous condition of the Brazilian staphylinid beetles, he returned to Perth, November 6, 1905. Finding them all dead and with nothing further to detain him he again sailed for China on May 29th, 1906, taking with him from Sydney small citrus trees infested with the red, black, and purple scales upon which to colonize the parasites collected. Scale-infested trees were also sent to him in China from California for this purpose. These were placed in a Chinese garden while he made a trip to India where he collected a parasite of the melon fly and various fruit flies and shipped the parasitized pupæ on the steamer *Orient* which sailed from Bangalore, September 16, 1906. Although these parasites arrived in Australia in splendid condition, the season was untimely, there being no fruit fly larvæ available, so they perished. Compere returned to China and noted an earwig destroying the maggots of the fruit flies and house flies at Kowloon, near Hongkong, but it was never sent to Australia because of the fear of its becoming a pest. The scale-infested trees, consisting of thirteen cases and carrying various parasites, secured in China and India, were shipped to California from Hongkong on the steamer *America Maru*, October 20, 1906. When they arrived in San Francisco they were received by E. K. Carnes and placed in an insectary built in the yard of John Isaac, Secretary of the California State Horticultural Commission. After a short time spent in securing scale parasites in Japan, Compere sailed for California and arrived at San Francisco, December 17, 1906. With his extensive knowledge of the fruit fly situation over much of the world he was able to convey extraordinarily valuable information to Ellwood Cooper concerning the importance of preventing the entrance of fruit flies into California. He further expressed his belief in the finding of a specific parasite for the Mediterranean fruit fly and thought the only source of help lay in introducing the available fruit fly parasites of India into Western Australia. With the consent of Cooper he left for Western Australia on January 19, 1907, and arrived at Perth, March 11, where, after an interview with the officials there, he left Perth on May 1st for India. Small citrus trees infested with red scale were sent to China from California to secure further parasites. He arrived at Colombo, Ceylon, May 8th, where he collected a parasite of the cabbage aphis, and sent it to

Western Australia. Having visited many places in India and established headquarters at Bangalore, he returned to Western Australia, June 22, where he remained a month and again sailed for Bangalore July 23, arriving there August 12th, 1907. He procured a guava orchard and collected from 70,000 to 100,000 parasitized fruit fly pupæ and returned with them on ice to Australia where he landed December 7, 1907. Four days later the parasites began to emerge and were provided with the larvæ of the Mediterranean fruit fly. In all he estimated that two million parasites of one species and about three hundred of another, issued from the Indian material. Adults were recovered on January 7, 1908, which demonstrated the ability of the parasites to propagate on the Mediterranean fruit fly. Here Compere's account ended but Howard and Fiske[252] stated that "In April, 1908, it was reported that 120,000 parasites had been obtained and distributed, 20,000 of them having been sent to South Africa."

On October 11, 1907, J. W. Jeffrey succeeded Ellwood Cooper as State Horticultural Commissioner in California but Compere's work continued the same. In March, 1908, he again visited China where he collected during March and April and forwarded a mealybug parasite to California. Late in April, 1908, he went to Japan and returned to California in May where he remained a short time before proceeding to Europe. In July, 1908, he collected in Germany and sent parasitized material to California including a parasite of the European elm scale, *Gossyparia spuria* (Modeer), several parasites of lecanium scales and a number of coccinellids.

Compere arrived in Hongkong, September 9, 1908, where according to the new plans of J. W. Jeffrey, a temporary insectary was established for the purpose of propagating the Chinese parasites. From China large quantities of parasitized material were forwarded to Sacramento, where a new insectary had been built in 1907 with E. K. Carnes as superintendent. In fact so much was sent over that in December, 1908, Compere was instructed that because of a shortage of funds, to cut down on shipments. Nothing of any importance was established in California as a result of these sendings. In January, 1909, Compere visited the Philippines and shipped a number of ladybird beetles to California. A severe ear trouble due to the tropics caused him to return to Perth, Aus-

[252] Howard, L. O., and Fiske, W. F., U. S. Dept. Agr., Bur. Entom., *Bul. 91*, p. 39 (1911).

tralia, on April 19, 1909. After a six weeks' stay there he again returned to the Philippines. Here he collected a number of parasites and predators and accompanied them in person to California, where he arrived in the fall of 1909. The trip was apparently unsuccessful, because he returned to the Philippines in March, 1910, where other beneficial insects were collected. Among them was a small ladybird, *Scymnus bipunctatus* Kugel.,[253] a predator on mealybugs. Compere returned with these beetles to California where they were propagated and distributed through his own efforts throughout the southern part of the state in 1910 and 1911.

I received a good colony when at Santa Paula, delivered by Compere in person. This was the last introduction made by Compere. He severed his connections with Australia and thereafter he was employed as chief deputy quarantine officer at the port of San Francisco by the State Commission of Horticulture, which position he held until his death. This rather long and detailed account is given to show the difficulties besetting the foreign collecting, transportation, rearing, and establishing as well as the vast amounts of energy and money expended to accomplish very meager results.

H. L. Viereck, specialist in parasitic Hymenoptera, was employed as foreign collector by the California State Horticultural Commission in 1914 and sent to southern Europe to seek parasites of the various citrus pests which occurred in California. He sailed from New York, March 5, 1914, and after visiting Italy, established himself in Sicily. At Palermo in June he discovered a new and effective enemy of the citrus mealybug, which has since been named the Sicilian mealybug parasite, *Leptomastidea abnormis* (Girault), colonies of which were sent to California during July and August, 1914. It propagated rapidly in confinement and was soon distributed in quantities throughout the state. It attacks only the citrus mealybug, but has practically eliminated it in certain of the citrus orchards of southern California. Viereck returned to California late in 1914 and soon afterwards resigned the position with the state.

E. J. Vosler, formerly assistant superintendent of the State Insectary and Secretary of the State Horticultural Commission, made two special collecting trips to Australia in an attempt to collect parasites which would attack the beet leafhopper, *Eutettix*

[253] This was originally reported as *Cryptogonus orbiculus* (Schœn.), a Japanese species.

tenellus (Baker), in California. The traveling expenses of his trips were defrayed by the sugar beet interests in the state. On the first trip he sailed from San Francisco in January, 1917, and arrived at Sydney, February 22, 1917. He collected and sent to California an undetermined dryinid parasite from New South Wales, of which only one living adult arrived and the species perished, and also a leafhopper egg parasite, *Pterygogramma acuminata* Perkins, which was observed in the insectary, but not distributed. He returned June 15, 1917. On the second trip he was also instructed to collect other beneficial insects as well as leafhopper parasites. He left San Francisco, January 1, 1918, and arrived at Honolulu, January 7th where he spent a few hours looking over the biological control work there. He next touched at Tutuila and Samoa and reached Sydney, January 22d. He then regularly sent back to California the egg parasite referred to above as well as an unnamed mymarid egg parasite. Both of these failed to propagate on the eggs of the beet leafhopper in California.

However, on this trip Vosler accomplished one notable thing, the introduction into California of Lounsbury's parasite of the black scale, *Metaphycus lounsburyi* (Howard) (*Aphycus*), which had been previously introduced into Australia from South Africa.

The efficient work of the coccid moth, *Eublemma cocciphaga* (Meyrick), so impressed Vosler that he sent it again to California. Although adults were reared it failed to become established in the state.

In addition to the above Vosler also sent to California the coccid parasites *Anagyrus* sp. and *Leptomastix* sp., the internal parasites *Pachyneuron* sp., and *Tetracnemus* sp., and a small encyrtid, as well as the two coccinellids, *Rhizobius plebejus* (*plebeius*) Blackb. and *Midus pygmæus* Blackb. A colony of the latter was also brought back by him on his first trip.

E. W. Rust was appointed foreign collector for the State Insectary in 1921 and continued in that capacity until 1928. He was first specially charged to collect parasites of the black scale in South Africa where he established headquarters at Cape Town, about the middle of 1921. The first shipment from him was received in September of that year. He returned to Whittier, California, where the branch insectary was then located, on December 22, 1921, having sent over twenty-four species of parasitic and predacious insects. From South Africa the most promising parasite of the

black scale was *Coccophagus trifasciatus* Compere, which was reared in confinement and a small colony liberated at Covina. From South Africa he brought specimens of a ladybird beetle, *Scymnus binævatus* Muls., predacious on mealybugs. From Hawaii he sent 250 specimens of *Encyrtus infelix* Embleton, a parasite of the soft brown scale and hemispherical scale, a surplus of which was liberated in Los Angeles, Pasadena, and East Whittier. Returning to South Africa he continued to forward material to California. He was a prolific collector and forwarded a great many interesting and important beneficial insects to California as shown in the list on pp. 385–393.

In 1924 and 1925 F. Silvestri collected parasites of the black scale, red scale, Florida red scale, and purple scale in Japan and China. Among these were: *Azotus perspiciosus* (Gir.), *Casca chinensis* Howard, *Anysis saissetiæ* (Ashm.), and *Comperiella bifasciata* Howard.

Charles F. Henderson was appointed foreign collector under the joint auspices of the Bureau of Entomology and the University of California in October, 1926, and served until December, 1928. His salary was paid by the former and his expenses by the latter. He was employed to take up the search for natural enemies of the beet leafhopper in South America, Mexico and some of the Western states. His first trip was to the Argentine Republic,[254] and he sailed from San Francisco, October 9, 1926, and arrived at Bahia Blanca on November 10, 1926. He investigated the sugar beet industry, leafhoppers and parasites in the provinces of Tucuman, Jan Jaun, Mendoza, Buenos Aires and the territories of La Pampa and Rio Negro during a period of seven and one-half months. The beet leafhopper was not found in any of these places [255] but a beet-infesting leafhopper, *Eutettix* sp., was found which greatly resembled *E. tenellus* (Baker), and which caused a disease similar to curly top. He also visited Uruguay, January 24–28, 1927, but found neither the leafhopper nor the disease there. He returned in June, 1927, without finding a parasite suitable for introduction into California.

It was then decided to extend the search for beet leafhopper

[254] Henderson, C. F., *Exploration in the Argentine Republic for parasites of the beet leafhopper,* Eutettix tenellus *(Baker),* Jour. Econ. Entom., vol. 21, pp. 863–871, fig. 59 (1928).

[255] Severin, H. H. P., and Henderson, C. F., *Beet leafhopper,* Eutettix tenellus *(Baker) does not occur in the Argentine Republic,* Jour. Econ. Entom., vol. 21, pp. 542–544 (1928).

parasites to parts of Mexico and certain of the Western states where this insect was most likely to be indigenous. In an automobile Henderson explored central Mexico from October 3 to December 10, 1927; Lower California, April 28 to May 22, 1928 and the west coast of Mexico, June 16 to July 16, 1928. In these regions he found the following egg parasites, which are also known to attack the eggs of the beet leafhopper in California: *Polynema eutettigis* Girault (*P. eutettixi* Gir.), *Gonatocerus* sp., *Abbella subflava* Gir., *Aphelinoidea plutella* Gir., *Anthemiella rex* Gir., and *Anapes* sp. *Ufens* sp. and *Phanurus* sp., occur in California and Mexico where the beet leafhopper was found in almost pure populations, but it is not yet determined if these parasites complete their entire life cycles on the eggs of this particular leafhopper. *Polynema* sp., *Ittys* sp., and a new trichogrammatid were found associated with almost pure populations of the beet leafhopper, but have not been tested experimentally. The survey in Arizona, July 22 to August 22, 1928; Utah, August 27–31, 1928; and Idaho, September 1–6, 1928, was made to find the northern limits of these parasites, several of which were traced as far north as Twin Falls, Idaho. *Anagrus giraulti* Crawford, which attacks the eggs of the beet leafhopper in California, was found in Utah and Idaho, but not in Mexico.

Harold Compere, son of George Compere, and assistant in entomology in the Citrus Experiment Station, made a special trip to Australia, New Zealand, and some of the South Pacific Islands in 1927–1928,[256] to find, if possible, the native home of the citrophilus mealybug, *Pseudococcus gahani* Green, in order to secure natural enemies of the same for introduction into California, where this mealybug has become a widespread and serious pest. He sailed from San Francisco for Australia in August, 1927. He soon discovered the citrophilus mealybug on oleander and *Choisya* at Sydney where natural enemies were also present. After preparations had been made to transport colonies of parasitized mealybugs to California, Compere made arrangements with the government entomologist, Davis Miller, at Wellington, New Zealand, to secure an additional supply of mealybugs there to be used as food en route to California. The citrophilus mealybug was also discovered at New Zealand, where it is thought to have been intro-

[256] Smith, H. S., and Compere, H., *The introduction of new insect enemies of the citrophilus mealybug from Australia*, Jour. Econ. Entom., vol. 21, pp. 664–669 (1928); Calif. State Dept. Agr., *Mthly. Bul.*, vol. 18, pp. 214–218 (1929).

duced from Australia, and where it had become a serious pest of deciduous fruits. He arrived at Riverside, California, in March with six species of parasites and predators as indicated in the list, pp. 385–395. The most important of these, *Coccophagus gurneyi* Compere,[257] was successfully reared and liberated in the orchards and is becoming abundant in some of the citrus orchards infested with citrophilus mealybug in Orange and Los Angeles counties, where it was first liberated. Another hymenopterous parasite, *Tetracnemus prætiosus* Timb., also on the same host, has been permanently established in southern California as well as several of the others brought over by Compere.

Insectaries[258]

It was many years before the California State Horticultural officials realized the need of a properly built and fully equipped insectary.

While the early officials tried not to rely upon the foreign collector to separate out the primary and hyperparasites, whatever was sent back was too often liberated directly in the orchards and fields without any question as to the hazards being taken.[259] The material sent over from Australia by Kœbele was sent directly to B. M. Lelong, Ellwood Cooper, and D. W. Coquillett. Lelong and Cooper liberated what was received direct while Coquillett, who was the only trained entomologist in the state at the time, took many more precautions. Nearly all of the material received by him was either reared in glass jars in his office or under tented trees, the latter being the first type of insectary for breeding insects used

[257] Compere, H., *Description of a new species of* Coccophagus *recently introduced into California*, U. S. Pub. Entom., vol. 5, no. 1, pp. 1–3, figs. 1–2 (1929).

[258] Smith, H. S., *A sublaboratory of the insectary in the south*, Calif. State Hort. Com., vol. 5, p. 307 (1916).

Smith, H. S., and Armitage, H. M., *Biological control of mealybugs in California*, Calif. State Dept. Agr., Mthly. Bul., vol. 9, pp. 104–158, figs. 39–67, 1 col. pl. (1920).

State Insectary, figs. 39, 46.

Practical application of biological control, pp. 123–145, figs. 48–56.

Branch insectaries, pp. 146–149, figs. 57–60.

Building and equipment, pp. 150–158, figs. 61–67 (includes plans for building, rearing cages, tables, trays and arrangement of trays).

H. S. Smith and H. Compere have read and suggested changes and additions to this portion on insectaries.

[259] H. S. Smith comments on this practice as follows: "I do not believe that the foreign collector was ever relied upon to separate out the primaries. Generally it would be a practical impossibility. Both Kœbele and Geo. Compere continually warned the people in California to watch out for secondaries."

THE MOST IMPORTANT PARASITIC AND PREDACIOUS INSECTS INTRODUCED INTO CALIFORNIA FOLLOWING THE WORK OF A. KŒBELE

Hymenopterous Parasites

Insect	Collector	Original Home	Hosts	Number Sent	Date Received
Apanteles glomeratus (Linn.)	Through Bureau of Entomology	Europe	Cabbage butterfly, *Pieris rapæ* (Linn.)		June, 1915
Calliephialtes messor Grav.	Geo. Compere	Spain	Codling moth	Large numbers	1904–1905
Aneristus ceroplastæ How.	E. W. Rust	So. Africa. Has wide distrib. in tropics	Many unarmored scales	Few	Dec., 1921
Azotus perspiciosus (Gir.)	F. Silvestri	Shanghai, China	Florida red scale	2 adults	Jan., 1925
Casca chinensis How.	Geo. Compere, F. Silvestri	China "	Red and purple scale "	2 adults 650 adults reared	1907 1924
Coccophagus anthracinus Comp.	E. W. Rust	So. Africa	Black scale	Many	Sept., 1923
C. atratus Comp.	"	"	*Ceroplastes* sp.		July 11, 1924
C. bifasciaticorpus Girault	"	"	Black scale		Fall of 1921

THE MOST IMPORTANT PARASITIC AND PREDACIOUS INSECTS INTRODUCED INTO CALIFORNIA FOLLOWING THE WORK OF A. KŒBELE—*Continued*

Hymenopterous Parasites—Continued

INSECT	COLLECTOR	ORIGINAL HOME	HOSTS	NUMBER SENT	DATE RECEIVED
C. gurneyi Comp.	H. Compere	Australia	Citrophilus mealybug		Mar., 1928
C. japonicus Compere	C. P. Clausen	Japan	Citricola scale	515 adults	June 3, 1923
C. malthusi Gir.	E. W. Rust	So. Africa	*Ceroplastes* sp.		Apr. 16, 1924
C. modestus Silv.	C. W. Mally E. J. Vosler E. W. Rust	So. Africa N. S. W., Australia So. Africa	Black scale " "	2 colonies Colony Great numbers	June, 1915 1918 1921–1923
C. ochraceus How.	E. W. Rust	So. Africa	"		1921 (?)
C. trifasciatus Comp.	C. P. Lounsbury C. W. Mally E. W. Rust	" " "	" " "		1912 1924–1925
C. yoshidæ Nakay.	C. P. Clausen "	Japan "	Soft brown scale and citricola scale "	27 females 9 adults	June 4, 1922 June 3, 1923
Tetracnemus sp.	E. J. Vosler	Australia	Coccids		1919

THE MOST IMPORTANT PARASITIC AND PREDACIOUS INSECTS INTRODUCED INTO CALIFORNIA FOLLOWING THE WORK OF A. KŒBELE—*Continued*

Hymenopterous Parasites—Continued

INSECT	COLLECTOR	ORIGINAL HOME	HOSTS	NUMBER SENT	DATE RECEIVED
Mariettc carnesi (How.)		Japan	Secondary		Disposition unknown. May have been liberated.
Prospaltella maculata How.	Geo. Compere	China	Purple scale	Colony	1900
* *Aspidiotiphagus citrinus* (Craw)	"	Hawaii	Armored scales	"	1898–1899
Aphytis chrysomphali (Mercet)	"	"	"	"	"
Anysis saissetiæ (Ashm.)	F. Silvestri	China	Black scale	475 adults	Jan. 16, 1925
Aphobetoideus comperei Ashm.	E. W. Rust	So. Africa	"	48 adults	Nov., 1921
* *Tomocera californica* How.	Geo. Compere	Australia	"	Thought to have been accidentally introduced	1900
Ophelosia crawfordi Riley	"	"	Cottony cushion scale	Colony	"

* Became permanently established in California.

THE MOST IMPORTANT PARASITIC AND PREDACIOUS INSECTS INTRODUCED INTO CALIFORNIA FOLLOWING THE WORK OF A. KŒBELE—*Continued*

Hymenopterous Parasites—Continued

INSECT	COLLECTOR	ORIGINAL HOME	HOSTS	NUMBER SENT	DATE RECEIVED
* *Scutellista cyanea* Mots.	C. P. Lounsbury C. W. Mally	So. Africa	Black scale	17 adults Other sendings	1901 1904
Anagyrus aurantifrons Comp.	E. W. Rust	"	*Pseudococcus* sp.		1921
Anicetus annulatus Timb.	C. P. Clausen	Japan	Citricola scale	7 adults	June 3, 1923
Aphycus sp.	"	"	"	25 adults	June 4, 1922
Metaphycus helvolus Comp.	E. W. Rust	So. Africa	Unknown		July, 1924
M. punctipes Dahlb.	C P. Clausen	Japan	Citricola scale		June 3, 1913
* *M. lounsburyi* (How.)	C. P. Lounsbury C. W. Mally E. J. Vosler	So. Africa " N. S. W., Australia	Black scale " "	Two shipments One shipment Small colony	1912 1914 1917
Comperiella bifasciata How.	Geo. Compere C. P. Clausen F. Silvestri	China Japan China and Japan	Red scale Red scales "	Trees infested with red scale exposed to parasites in China, 13 cases 15 adults Colony	Oct. 20, 1906 1907 July 9, 1922 1924

* Became permanently established in California.

THE MOST IMPORTANT PARASITIC AND PREDACIOUS INSECTS INTRODUCED INTO CALIFORNIA FOLLOWING THE WORK OF A. KŒBELE—*Continued*

Hymenopterous Parasite—Continued

INSECT	COLLECTOR	ORIGINAL HOME	HOSTS	NUMBER SENT	DATE RECEIVED
Encyrtus infelix Embl.	E. W. Rust	Hawaii	Hemispherical scale	Colony	1921
* *Leptomastidea abnormis* (Gir.)	H. L. Viereck	Sicily	Citrus mealybug	Several colonies	1914
Tanaomastix albiclavata (Ashm.)	Geo. Compere	Philippine Islands	*Pseudococcus* sp.		1905 (?)
* *Quaylea whittieri* (Girault)	"	Australia	Secondary on black scale	33 colonies	1901
Pauridia peregrina Timb.	P. H. Timberlake	China (Hawaii)	*Pseudococcus* sp.		1919
Myiocnema comperei Ashm.	Geo. Compere E. W. Rust	Queensland, Australia N. S. W., Australia	Reported on half-grown black scale "	 Shipment	1900 1921 (not propagated)
Lecanobius cockerelli Ashm.	H. A. Ballou Bur. Entom.	West Indies, Florida	*Lecanium* spp. *Saissetia* spp.	Specimens	1913 1915 (not liberated)
Zalophothrix mirum Crawf.	H. A. Ballou	British West Indies	Hemispherical and black scales		1913

* Became permanently established in California.

The Most Important Parasitic and Predacious Insects Introduced into California Following the Work of A. Kœbele—*Continued*

Hymenopterous Parasites—Continued

Insect	Collector	Original Home	Hosts	Number Sent	Date Received
* *Pteromalus puparum* (Linn.)		Europe	Cabbage butterfly		Introduced prior to 1908
Ootetrastichus beatus Perkins	O. H. Swezey	Australia (sent from Hawaii)	Sugar cane leafhopper		1916
Tetrastichus injuriosus Comp.	E. W. Rust	So. Africa	Secondary on black scale		1924 (not liberated)
Pterygogramma acuminata Perkins	E. J. Vosler	Australia	Eggs of leafhopper	Several colonies	1917, 1918

Dipterous Parasites and Predators

Insect	Collector	Original Home	Hosts	Number Sent	Date Received
Locustivora pachytyli (Skuse)	Geo. Compere	N. S. W., Australia	Grasshoppers		1900
Fannia canicularis (Linn.)	"	Australia	"	59 adults Other lots	June 14, 1900, Feb. 10 and 24, 1901
Diplosis sp.	H. Compere	"	Citrophilus mealybug		March, 1928

* Became permanently established in California.

THE MOST IMPORTANT PARASITIC AND PREDACIOUS INSECTS INTRODUCED INTO CALIFORNIA FOLLOWING THE WORK OF A. KŒBELE—*Continued*

Lepidoptera

INSECT	COLLECTOR	ORIGINAL HOME	HOSTS	NUMBER SENT	DATE RECEIVED
* *Eublemma cocciphaga* (Mey.)	Geo. Compere E. J. Vosler	Australia "	Black scale "	Colony 17 adults	1900 1918
Erastria scitula Ramb.	Through L. O. Howard and A. Berlese	Italy	"	Pupæ	1901
Lætilia coccidivora Comst.	G. F. Moznette	Florida	"	Colony	1917, 1922

* Also sent over by Kœbele as *Thalpochares cocciphaga* Mey. in 1892.

Neuroptera

INSECT	COLLECTOR	ORIGINAL HOME	HOSTS	NUMBER SENT	DATE RECEIVED
Chrysopa sp.	H. Compere	Australia	Citrophilus mealybug		March, 1928

Coleoptera

INSECT	COLLECTOR	ORIGINAL HOME	HOSTS	NUMBER SENT	DATE RECEIVED
Calosoma sycophanta Linn.	Through L. O. Howard and A. F. Burgess	Europe (Recd. from Massachusetts)	Various caterpillars "	 1000 adults	April, 1913 1918
* *Carabus nemoralis* Müll.	Accidentally introduced	Europe	"		In S. F. prior to 1919. In Eureka, 1928

* Became permanently established in California.

The Most Important Parasitic and Predacious Insects Introduced into California Following the Work of A. Kœbele—*Continued*

Coleoptera—Continued

Insect	Collector	Original Home	Hosts	Number Sent	Date Received
* *Adalia bipunctata* (Linn.)	B. M. Lelong	Eastern U. S.	Aphis	Colony	1899
Coccinella arcuata Fabr.	Geo. Compere	Australia	"	"	1900
C. septempunctata Linn.	Through L. O. Howard	Europe	"	"	Nov. 18, 1901
C. repanda Thunb.	Geo. Compere	Australia	"	"	1900
C. religiosa Lea	"	Queensland, Australia	"	"	"
Leis conformis Bdv.	"	New South Wales, Australia	"	"	1899
Neda testudinaria Muls.	"	"		"	"
Ptychanatis axyridis Pall.	C. P. Clausen	Japan	Aphis	"	July, 1916
Chilomenes sexmaculata (Fabr.)	P. H. Timberlake	India	"	30 adults	1912
Chilocorus similis Rossi	C. P. Clausen	Japan	San José and other armored scales	Colony	1916
	"	"	"	45 adults	June 3, 1923

* Became permanently established in California.

THE MOST IMPORTANT PARASITIC AND PREDACIOUS INSECTS INTRODUCED INTO CALIFORNIA FOLLOWING THE WORK OF A. KŒBELE—*Continued*

Coleoptera—Continued

INSECT	COLLECTOR	ORIGINAL HOME	HOSTS	NUMBER SENT	DATE RECEIVED
C. circumdatus Schœn.	Geo. Compere	Hawaii, Australia	San José and other armored scales	Colony "	1898–1899 1900
C. bipustulatus (Linn.)	F. Silvestri	Italy	Unarmored scales	"	1915
Exochomus quadripustulatus (Linn.)	"	"	"	"	"
Hyperaspis japonica (Cr.)	C. P. Clausen	Japan	"	90 adults	June 3, 1923
Scymnus sp.	P. H. Timberlake	Hawaii	Mealybugs	Colony	1918
* *S. bipunctatus* Kugelann	Geo Compere	Philippine Is.	"	1000 adults	1910
* *S. binævatus* Muls.	E. W. Rust "	So. Africa "	" "	Colony 29 adults	Dec., 1921 March, 1922
S. notescens (Blackb.)	Geo. Compere	New South Wales, Australia	Red spiders	Colony	1900
* *Stethorus vagans* (Blackb.) †	" "	" "	" " "	" " "	Feb., Apr., 1900 Feb. 10, 1901 Mar. 18, 1901
Diomus sp.	H. Compere	"	Citrophilus mealybug		March, 1928

* Became permanently established in California.

† Smith believes that all subsequent records of this species in California refer to *S. picipes* Casey and that the former never became established here.

THE MOST IMPORTANT PARASITIC AND PREDACIOUS INSECTS INTRODUCED INTO CALIFORNIA FOLLOWING THE WORK OF A. KŒBELE—*Continued*

Coleoptera—Continued

INSECT	COLLECTOR	ORIGINAL HOME	HOSTS	NUMBER SENT	DATE RECEIVED
Pullus sp.	H. Compere	New South Wales, Australia	Citrophilus mealybug	Colony	March, 1928
Orcus australasiæ (Bdv.)	Geo. Compere	"	Various coccids	"	1899 Jan., 1900
O. chalybeus (Bdv.)	"	Hawaii, New South Wales, Australia	"	"	1898–1899 1900–
Anisorcus affinis Crotch	"	"	"	"	1900
* *Novius kœbelei* (Olliff)	"	"	"	"	"
Cœlophora inæqualis (Fabr.)	"	"	"	"	1899 1900
C. masteris Blackb.	"	"	"	"	1900
Archæioneda tricolor (Fabr.)	"	"	"	"	"
Verania lineola (Fabr.)	"	"	"	"	"
Rhizobius plebejus Blackb.	E. J. Vosler	New South Wales, Australia	Various coccids	"	1918

* Became permanently established in California

THE MOST IMPORTANT PARASITIC AND PREDACIOUS INSECTS INTRODUCED INTO CALIFORNIA FOLLOWING THE WORK OF A. KŒBELE—*Continued*

Coleoptera—Continued

INSECT	COLLECTOR	ORIGINAL HOME	HOSTS	NUMBER SENT	DATE RECEIVED
R. satellus Blackb.	Geo. Compere	New South Wales, Australia	Red scale	Colony	1899 1900
R. hirtellus Crotch.	"	"	Various coccids	"	1900
R. ventralis (Er.)	"	"	"	"	1899
Cleobora mellyi Muls.	"	"	"	"	1900
Sticholotis punctatus Cr.	"	Hawaii	Armored scales	"	1898–1899
Cryptolæmus montrousieri Muls.	"	"	Mealybugs	"	"
Platyomus lividigaster Muls.	" "	" New South Wales, Australia	Aphis "	" "	" 1899

in the state (Fig. 119). In order to preserve the vedalia during the winter of 1890–1891, the State Board of Horticulture erected two octagonal glasshouses at San Gabriel, each covering an orange tree (Fig. 120).

Alexander Craw reared many of the parasites received by him during his term of office at San Francisco, from 1890 to 1908, in

FIG. 119.—The first insectary in California consisted of a thin tent covering a small scale-infested orange tree. In it D. W. Coquillett reared the vedalia received from Albert Kœbele in Australia and liberated the adults in the orange orchards of southern California. Some of the material received from Kœbele was also liberated directly in the orchards. (U. S. Dept. Agriculture, 1899.)

large glass jars and insect cages, consisting of a framework of glass or covered with cheesecloth.

John Isaac had a number of such cages in his back yard in Sacramento during 1904–1906.

In 1907 the State Insectary (Fig. 121) was finished in Capitol

Park, Sacramento, and served as the headquarters for all the biological control work in California until the insectary work was transferred to the Whittier Laboratory in 1921. The State Insectary was of wooden-frame and stucco construction in the form of a square with a large open square court [260] in the middle. The walls of the rooms surrounding the court were largely of glass so as to admit plenty of light. The building was well equipped with insect-rearing devices, insect-rearing rooms for handling incoming ship-

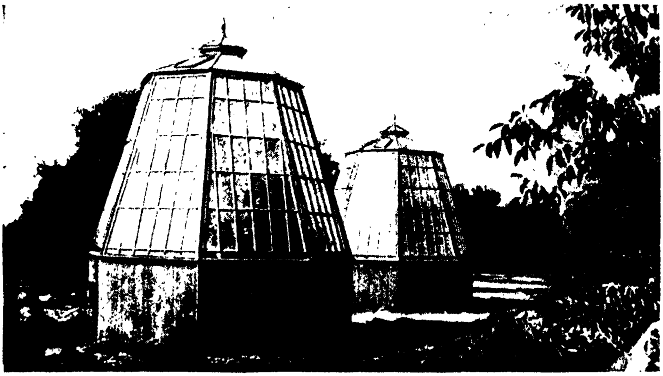

FIG. 120.—These two octogonal glass houses, covering orange trees, were erected by the California State Board of Horticulture as a winter refuge for the vedalia. They were constructed at San Gabriel at a cost of $650.15. (Calif. State Board of Horticulture, 1889.)

ments of beneficial insects, museum room and collection room, offices, dark rooms, storage rooms, and the necessary entomological supplies.

The first superintendent was E. K. Carnes, who served from 1907 to 1912. H. S. Smith [261] succeeded from 1912 until 1923. A portion of the building was turned over to the chemistry division of the State Department of Agriculture in 1921, and finally the entire building in 1923. A sublaboratory of the state insectary was established at Alhambra in 1916 to rear the Sicilian mealybug parasite, *Leptomastidea abnormis* (Girault).

Here Smith stationed Branigan to demonstrate the value of potato sprouts for propagating mealybugs and black scale and thereby revolutionized insectary practices. The main work of the

[260] A glass roof was placed over this court in 1914.

[261] Much of the interior of the building was remodeled by Smith. Certain rooms were made insect-proof in order to properly and safely handle foreign material.

insectary was moved to Whittier in 1921 to a building known as the Whittier Laboratory and loaned to the State Department of

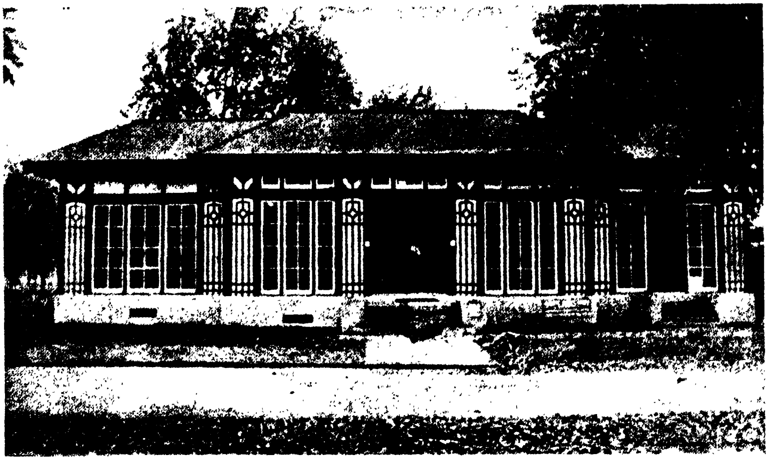

FIG. 121.—The California State Insectary constructed in the Capitol Park in 1907 and used as the headquarters for the biological control work in California until 1923. (After California State Engineering Dept.)

Agriculture by the University of California for insectary purposes, while headquarters were retained at Sacramento. This move was

FIG. 122.—A shipment of mealybug parasites received at the State Insectary at Sacramento from the Orient. The cases used for this purpose are shown. (After H. S. Smith and H. M. Armitage, 1920.)

suggested by H. S. Smith, who continued as superintendent, in order to secure conditions more favorable for the rearing of natural

enemies of citrus pests and to be in closer touch with the orchard problems involved. During the period of the Whittier Laboratory, 1921–1923, insectary work received a great impetus, although a

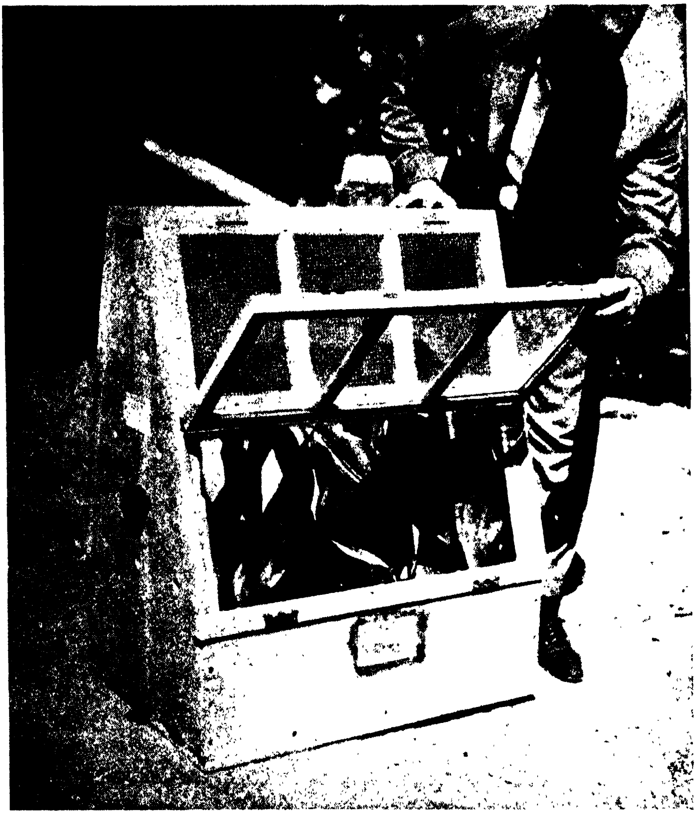

FIG. 123.—The type of cage used by the California State Insectary in importing beneficial living insects. (Photograph furnished by H. S. Smith, 1930.)

number of insectaries had already been organized in southern California just prior to that time. Up to this time propagation of *Cryptolæmus* was carried out in cages. Later H. M. Armitage introduced an important improvement in insectary practice, eliminating the individual cages and placing the trays in the open room, where the entire process was carried out without moving the trays. This change made possible the greater production of *Cryptolæmus* at a greatly reduced cost. The first branch of the state insectary was established at Santa Paula in 1918.

Insectary	Founded	Equipment	Number of Cryptolæmus Reared in 1928	Superintendent
State Insectary Sacramento	1907–1921	One building		E. K. Carnes, 1907–1912; H. S. Smith, 1912–1923
Riverside	1923	"		H. S. Smith, 1923–
Alhambra Branch (for black scale)	1916–1921	"		E. J. Branigan, 1916–1918
Alhambra Branch (for mealybugs)	1919–1921	"		H. Compere, 1919–1921
Ventura County Branch, Santa Paula	1918–1921	"		A. A. Brock, 1918
Whittier	1921–1923	"		H. M. Armitage, 1921–1923
Limoneira Company, Santa Paula	1916	Three buildings, 30 rooms	3,333,540	C. V. Newman, 1916–1918; S. H. Essig, 1919–1920; F. H. Gates, 1920–1924; Chas. Green, 1924–
Ventura County, Santa Paula	1918	Two buildings, 8 rooms	No records	A. H. Call, 1918–1919; C. H. Russell, 1919–1920; A. Pope, 1920–1921; C. R. Tower, 1921–1923; L. E. Onstott, 1923–1924; L. A. Scholl, 1924–
Santa Paula Citrus Association, Santa Paula	1919	Two buildings, 25 rooms	2,559,570	A. A. Brock, 1919–1922; C. H. Russell, 1922–; L. E. Onstott, 1922–; C. T. Dodds, 1923–1927; H. B. Sheldon, 1927–
San Bernardino County, Uplands	1920	One building	No report	C. E. Anderson, 1920

INSECTARY	FOUNDED	EQUIPMENT	NUMBER OF CRYPTOLÆMUS REARED IN 1928	SUPERINTENDENT
San Diego Land Corporation, Chula Vista	1920	One building	No report	
San Diego County, Chula Vista		"	168,776	W. S. Binney
San Gabriel Valley Pest Control Association, Lamanda Park	1921	Two buildings, 9 rooms	2,162,935	S. H. Essig, 1921–
Orange County, Anaheim	1922	Twenty-two buildings	20,876,460	C. H. Russell, 1922–1924 D. W. Tubbs, 1924–
Oxnard Citrus Association, Hueneme		Many buildings	2,135,000	G. Y. Baker
Los Angeles County,				
Riviera *	1923	One building, 27 rooms	7,165,720 for both insectaries	H. M. Armitage, 1923–
Downey	1927	One building, 42 rooms		H. M. Armitage, 1927–
Riviera (new)	1929	One building, 24 rooms		H. M. Armitage, 1927–
Santa Barbara County, Santa Barbara	1924	Three buildings, 8 rooms	1,763,040	F. C. Greer, 1924–
San Joaquin County, Lodi	1924	One building, 7 rooms	†	S. G. Walsh, 1924–1928 P. F. Wright, 1928–
Riverside County, Riverside		One building	384,000	E. G. Tuthill
Bastanchury Ranch Co., Fullerton		"	200,000	
Fillmore Citrus Protective District, Fillmore	1926	One building, 7 rooms	700,000	H. B. Lorbeer, 1926–
C. C. Chapman, Fullerton	1926	One building, 4 rooms	250,000	C. H. Russell, 1926–
Powers Lemon Company, Ventura	1928	One building, 4 rooms	432,290	Fred Carter, 1928–
Totals 19 Insectaries		47 buildings	42,131,331	

* On April 9, 1929 the insectary building at Riviera burned destroying four millions of *Cryptolæmus montrousieri* Muls. The reconstruction of a modern insectary building comprising 24 production rooms of 150,000 *Cryptolæmus* capacity was begun in October of the same year.

† This insectary reared only *Scymnus nebulosus* Lec. and *S. guttulatus* Lec. to control *Pseudococcus maritimus* (Ehrh.) on grapes, 500,000 in 1928.

On July 1, 1923, the work of the State Insectary was transferred from the State Department of Agriculture to the University of California and headquarters were very shortly transferred from Whittier to the Citrus Experiment Station and School of Subtropical Horticulture at Riverside, where it now is.

"What is probably the most up-to-date insectary in the country for use in biological control work is being constructed on the grounds of the Citrus Experiment Station at Riverside, California. This insectary is designed to be insect proof. Its ground form is 'H'-shaped, having four similar units of five rooms each. Access to each room is had through a vestibule which is automatically darkened when any door is opened. The construction is of reinforced concrete with tile roof. Windows are double with air space intervening, heavy wire glass being used to avoid danger from breakage. The sash are steel, set in concrete, and immovable. All ventilation is forced through fine mesh silk bolting cloth. All air entering the rooms passes first through an air washer and then over the heating units, which consist of both gas furnace and electric resistance heaters. Each of the twenty rooms has an independent temperature control. The supply and exhaust ducts to each room are equipped with air-tight dampers, operable from the vestibule. This makes it possible to close off any one room and fumigate it. Throughout the construction of the plant, the 'insect-proof' idea has been emphasized over every other requirement."—H. S. Smith.

Smith is still in charge of the work and has associated with him H. Compere, P. H. Timberlake, A. J. Basinger, and S. E. Flanders. Much splendid scientific work has been done under the very able direction of Smith and the biological control work in California measures up with that in any other part of the world.

CHAPTER VII

INSECTICIDES

SOAP

Soap as an insecticide so far antedates the study of economic entomology that no time limits are possible. In this country as early as 1841 [1] T. W. Harris recommended solutions of soft soap suds for aphis. He states, "The water, tobacco tea, or suds should be thrown upon the plants with considerable force, and if they (plants) are of the cabbage or lettuce kind, or other plants whose leaves are to be used as food, they should subsequently be drenched thoroughly with pure water. Lice on the extremities of branches may be killed by bending over the branches and holding them for several minutes in warm and strong soap-suds. . . . To destroy subterranean lice on the roots of plants, I have found that watering with salt water was useful, if the plants were hardy; but tender herbaceous plants cannot be treated in this way, but may sometimes be revived when suffering from these hidden foes, by free and frequent watering with soap-suds." The discovery of kerosene emulsion by A. J. Cook in 1877 resulted from the additions of various amounts of kerosene to the soap sprays.

In 1882 whale oil soap was recommended for the control of the black scale on olives by Ellwood Cooper.[2] At the same time soap was also extensively used about Los Angeles to wash citrus trees infested with the cottony cushion scale.[3] Whale oil soap and dry sulfur and whale oil soap, sulfur and tobacco were also successfully used for the control of the red spider.

In 1883 Matthew Cooke [4] recommended methods of making soap for spraying and used soap in many of his remedies for all kinds of insects. In 1886 W. G. Klee [5] recommended a mixture composed of one-half pound of soap, one gallon of water, and one-half pound

[1] *Report on the insects of Massachusetts injurious to vegetation*, pp. 195–196 (1841).
[2] State Board of Hort. of Calif., *First Rept.*, p. 39 (1882).
[3] *Ibid.*, pp. 50–51 (1882).
[4] *Injurious insects of the orchard, vineyard*, etc. (Sacramento, H. S. Crocker & Co., 1883), pp. 368–421.
[5] Calif. Agr. Exp. Sta., *Bul. 56* (1886).

of dry tobacco, to be applied at 130° F., for the control of the woolly apple aphis. In the same year John Rock of San José first used soap as a spreader for London purple in spraying for the control of codling moth on apple trees. (See Spreaders, p. 461.)

In the developments of insecticides in later years soaps played a most important part in kerosene emulsions, the resin wash, crude

FIG. 124.—The first private insectary in California, established by the Limoneira Company, Santa Paula, 1916. Some of the first rearings of *Metaphycus lounsburyi* (Howard) were made here. (Photograph by S. H. Essig.)

carbolic acid emulsion, distillate emulsions, crude oil emulsions, and the proprietary compounds of miscible oils and oil emulsions.

Soap in the proportions of one pound to fifteen gallons of water was extensively used for the control of the grape leafhopper in 1906 [6] and with the addition of one pint of 40% nicotine sulfate, is still used for this purpose. During the period 1910–1915 soap at the rate of one pound for five to fifteen gallons of water was recommended for the control of the walnut aphis,[7] and continued to be used for this purpose until replaced by nicotine dust in 1917. During the period 1915–1918, due to the scarcity and high price of cyanide for fumigation purposes, powdered soaps were very ex-

[6] Quayle, H. J., Calif. Agr. Exp. Sta., *Bul. 192*, pp. 118–119 (1907).

[7] Smith, R. E., Calif. Agr. Exp. Sta., *Bul. 231*, p. 385 (1912).
Taylor, A. R., *ibid.*, *Circ. 131*, pp. 9–11 (1915).

tensively used in the citrus orchards of southern California for the control of the black scale. These commercial powders contained from 20% to 30% soap, and about 50% sodium carbonate. They were used at the rate of thirty-five to forty pounds to two hundred gallons of water. Five commercial brands were used. They frequently caused a spotting of the fruits and were soon discontinued.

In 1914 and during succeeding years the mealy plum aphis, *Hyalopterus arundinis* (Fabr.), became a serious pest of prune and plum trees in many parts of central California. The most economical summer spray proved to be a solution of five pounds of soap to one hundred gallons of water. This remedy continues to hold first place for the control of this pest today as well as for the hop aphis, rose aphis, and other species of aphis in the gardens and orchards of the state. The addition of nicotine sulfate and miscible oil make the soap solutions more effective, but not sufficiently so to offset the extra cost of the materials.

Alkaline washes and soaps were among the very first sprays used for the control of scale insects on both citrus and deciduous trees in California. As early as 1872, a mixture of Peruvian guano and soap suds was advocated for washing orange trees infested with scale insects. By 1882 concentrated lye or caustic soda was extensively used as a spray, particularly for the San José scale on deciduous fruit trees. It was used at the rate of one pound to one or one and one-half gallons of water.

In 1883 Matthew Cooke listed seven or more remedies containing lye, caustic soda or potash for various insects.[8]

In 1886 E. W. Hilgard, director of the California Agricultural Experiment Station, published a bulletin on alkaline washes for fruit trees [9] and gave methods for the preparation of the same.

Alkaline washes were used to a considerable extent until replaced by lime-sulfur shortly after the discovery of the latter in 1886.

The use of caustic soda was revived in connection with the distillates used for spraying of citrus fruit trees in 1908 and later also with crude oil for dormant spraying of deciduous fruit trees which reached the peak in 1911. (See oil emulsions.)

[8] *Injurious insects of the orchard, vineyard, etc.* (Sacramento, H. S. Crocker & Co., 1883), pp. 368–424.

[9] *Bul. 52* (1886).

Kerosene Emulsion [10]

Kerosene was used for the destruction of many kinds of insects long before the discovery of kerosene emulsion.

According to Lodeman, "Kerosene was recommended for the destruction of scales on orange trees in 1865, and was also successfully applied to oleander, sago-palm, acacia, and lemon trees. The oil was poured into a saucer and applied by means of a feather. . . . The insecticidal value of kerosene once being known, it was very natural that the oil and soap should be used together. The first record that I have found of such a mixture appeared in February, 1875.[11] George Cruickshank, of Whitinsville, Mass., here says that he had been fighting the currant worm since 1866, but at first with unsatisfactory results. 'In May, 1870, I began using kerosene with whale-oil soap, increasing the kerosene until it would kill the worm and not injure the foliage of the plant. I used 5 pounds of whale-oil soap, and 1 wine quart of kerosene to 25 gallons of soft water to mix. Stir the soap and kerosene together till thoroughly mixed; add two parts of hot water, stir till the soap is dissolved, then add the balance of cold water and it is ready for use.'"

Henry Bird of Newark, New Jersey, used a similar mixture the same year.

The name, kerosene emulsion, originated with C. V. Riley and H. G. Hubbard in 1880, but the first experimenter and advocate of such a compound was A. J. Cook of the Michigan Agricultural College in 1877. He recommended it to the public in 1878 in the following words: "The best substances for such use (to kill sucking insects) are a weak solution of carbolic acid, a strong suds either of whale-oil or common soap and tobacco water. I have found the addition of half a teacupful of crude petroleum (kerosene) to two gallons of either of the above makes them more effective." [12]

A more detailed account of this emulsion is given ten years later as follows: "I have found nothing so satisfactory in treating plant lice as the kerosene and soap mixture. To make this I use one-fourth pound of hard soap, preferably whale oil soap, and one quart of water, or one quart of common soft soap and one quart of water. This is heated till the soap is dissolved, when one pint of kerosene oil is added and the whole agitated till a permanent emulsion or mixture is formed. The agitation is easily secured by use of a force pump, pumping the liquid with force back into the vessel holding it. I then add water so that there shall be kerosene in the proportion of one to fifteen." [13]

In 1880, C. V. Riley [14] announced an emulsion by combining kerosene with either fresh or spoiled milk. This milk emulsion was first suggested by W. S. Barnard of Cornell University, who was then associated with the cotton worm investigations at Salem,

[10] Lodeman, E. G., *The spraying of plants* (New York, Macmillan, 1897), pp. 79–85.
Howard, L. O., U. S. Dept. Agr., *Yearbook, 1899*, p. 149 (1900).

[11] *Gardener's Monthly*, p. 45 (Feb., 1875).

[12] Cook, A. J., Mich. State Bd. Agr., *17th Ann. Rept.*, p. 434 (1878); Mich. Agr. Col., *Bul. 58* (1890).

[13] Cook, A. J., Mich. Agr. College, *Bul. 26*, p. 4 (1887).

[14] U. S. Commr. of Agr., *Rept. for 1880*, p. 288 (1881).

Alabama.[15] H. G. Hubbard,[16] an agent of the Division of Entomology working on citrus insects in Florida, perfected this spray in 1881–1882 and recommended the following formula:

Kerosene	1 gallon
Condensed milk	1½ pints
Water	3 pints

Mix thoroughly the condensed milk and water before adding the oil, churn with the Aquapult pump until the whole solidifies and forms an ivory-white glistening butter as thick as ordinary butter at a temperature of 75° F. For scale insects dilute 1 to 12 or 16 times.

Kerosene emulsion or kerosene butter was perfected during the next two years by Hubbard. His formula was:

Kerosene	2 gallons
Common soap	½ pound
Water	1 gallon

Heat the mixture of soap and water, and add it, boiling hot, to the kerosene. Churn the mixture by means of a force-pump and spray nozzle for five or ten minutes. The emulsion, if perfect, forms a cream, which thickens on cooling, and should adhere without oiliness to the surface of glass. Dilute, before using, one part of the emulsion with nine parts of cold water. The above formula gives three gallons of emulsion and makes, when diluted, thirty gallons of wash.[17]

In comparing the two kinds of kerosene emulsion, the Cook formula and the Riley-Hubbard formula, it will be seen that there were considerable differences in the two. Many difficulties followed, however, in the methods of preparation and many controversies arose as to which was the most satisfactory. In regard to this controversy, R. H. Smith has furnished the following comment: "The formula of Cook would be considered a temporary mixture rather than an emulsion. His formula called for 1 part oil and 2 parts of water. A good emulsion requires at least 2 parts of oil to 1 part of water, otherwise it will break down and the oil separate rather quickly."

Petroleum was used for the control of scale insects in California as early as 1881,[18] but not as an emulsion. It was quite extensively applied for the control of the San José scale, but usually with serious damage to the trees, since it was used during the summer.

[15] U. S. Entom. Comm., *Rept. 4*, p. 156 (1885).
[16] *Ibid.*, *Rept. for 1881–1882*, pp. 112–127 (1882).
[17] U. S. Entom. Comm., *Rept. 4*, p. 158 (1885).
Hubbard, H. G., *Insects affecting the orange*, U. S. Dept. Agr., Div. Entom., pp. 94–95 (1885).
[18] *Pacific Rural Press*, vol. 21, p. 72 (June 29, 1881).

In reference to kerosene emulsion Matthew Cooke in 1883 writes: "Personally, I am opposed to the use of mineral oils on trees or foliage, but deem it proper to give Professor C. V. Riley's remedy for scale insects, known as 'Kerosene Emulsion,' which he reports as giving excellent results." [19]

In 1885 Ellwood Cooper, President of the State Board of Horticulture of California, adopted the Hubbard formula, but in diluting

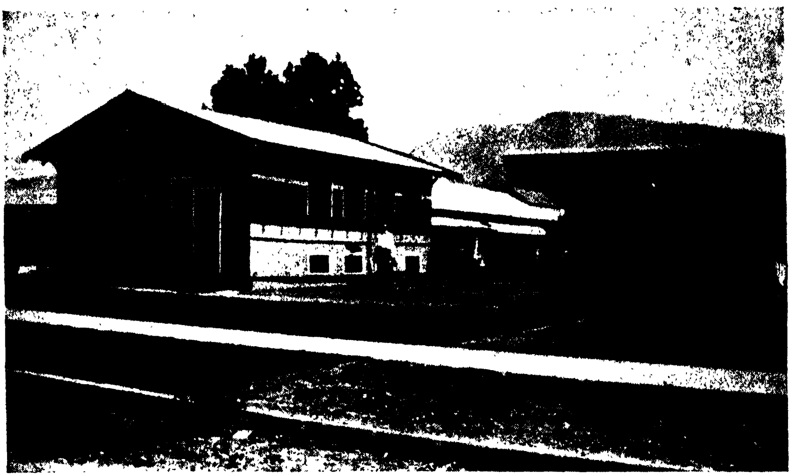

FIG. 125.—Insectary of the Santa Paula Citrus Association. Established in 1919, it was the first of the association insectaries. (Photograph by C. T. Dodds.)

it for olive trees (black scale) he used six and one-half gallons of water to one of oil. The cost of the mixture was four cents a gallon, and, using an average of sixteen gallons for a large olive tree, the cost for material alone was sixty-four cents per tree.[20] In the same year, W. G. Klee, State Inspector of Fruit Pests, advocated the Riley-Hubbard formula for scale insects, but had apparently made no tests with it at that date.[21] There was little or no change in either the Cook or Riley-Hubbard formulas made by the originators [22] and in fact they are altered but little when used today.

[19] *Injurious insects of orchard, vineyard, etc.*, p. 401 (1883).

[20] State Bd. of Hort. of Calif., *Bien. Rept.*, 1885 and 1886, pp. 35–36 (1887).

[21] *Ibid.*, p. 375 (1887).

[22] Riley, C. V., *U. S. Entom. Comm. Rept. 5*, pp. 36–37 (1890).
Cook, A. J., Mich. Agr. College, *Bul. 73*, pp. 3–7 (1891).
(Cook and Riley-Hubbard formulas compared and contrasted); *ibid.*, *Bul. 76*, pp. 3–8 (1891).

Kerosene was first recommended for the control of mosquitoes by L. O. Howard in 1892.

During the years 1895–1898 oils came into general use in southern California for the control of scale insects on citrus trees. Various types were used, but kerosene or water white oil and distillates of various grades were the most popular. Kerosene emulsions did not figure much in this new program, although they were often

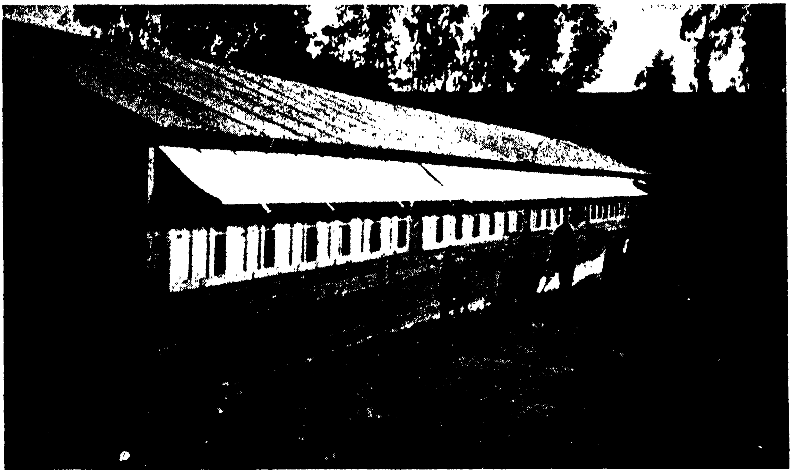

FIG. 126.—One of the two insectary buildings of the San Gabriel Valley Pest Control Association at Lamanda Park, erected in 1921. The two buildings have nine rooms. This was the first insectary organized by a group of fruit growers' associations. C. T. Dodds and F. H. Wymore are shown in the picture. (1923.)

recommended. A mechanical mixture [23] of the water white oil and water, applied by specially constructed power spraying machines, was very extensively used up to 1908. By 1901 injuries to the fruit and foliage became evident and investigations to avoid these were undertaken by W. H. Volck, University of California, in that year. He investigated the matter of emulsions and reported that

"the emulsions made from California oils have not usually been as satisfactory as those from Eastern kerosene, and a large amount of damage has been done by separated oil, which rises to the surface in spray tanks." He concludes that "the emulsions have proved unsatisfactory primarily because of the

[23] Wm. Saunders, Canada Dept. of Agriculture, used a mechanical mixture of kerosene and water in greenhouse work many years prior to 1878, Howard, L. O., U. S. Dept. Agr., *Yearbook*, 1899, p. 150 (1900).

difficulty of obtaining a stable article." In reference to the mechanical mixtures he states that "while the mechanical mixing idea preceded the emulsions, it is only in recent years that it has been perfected and made practicable. Mechanical mixing represents the most modern idea in practical spraying, and is certainly a great improvement over the 'stable' emulsions, which are so only in name." He also believed that the mechanical mixtures eliminated the injury to fruits because in the drops adhering to the fruit the oil separated more quickly and spread over a relatively greater surface. In summing up his investigations he recommended kerosene in preference to distillates stating that "although somewhat less effective as insecticides, from 8 to 10 per cent of the oil may be used with safety on citrus trees." [24]

By 1905 [25] the distillates of about 28° Baumé practically entirely replaced the kerosene and water white oils. They were used at 3% dilutions throughout the entire citrus area until an accumulation of injuries forced their discontinuance in the mechanical conditions soon after 1908. However, recommendation for their use continued for a number of years later,[26] but ceased by 1915, when strange to say the kerosene emulsion was again recommended as preferable to the mechanical mixture, but it was soon replaced by many kinds of proprietary oil sprays.

Distillate Emulsion

Distillate emulsion was originated by F. Kahles, the manager of a large citrus orchard at Santa Barbara, in 1900 [27] and was known as Kahles' spray. The original formula was:

Distillate (28° Baumé)	5 gallons
Water (boiling hot)	5 "
Whale oil soap	1½ pounds

It was prepared by adding the dissolved soap to the distillate and making an emulsion by continued running it through a spray pump under pressure. For dormant deciduous trees it was diluted one part to ten parts of water and for citrus trees, one part to fourteen parts of water.

The distillate-water mechanical mixture was originated in 1902 [28] by the Stearns Brothers and was known as the Stearns Brothers'

[24] Volck, W. H., *Spraying with distillates*, Calif. Agr. Exp. Sta., Bul. 153, 31 pp., 5 figs. (1903).
[25] Quayle, H. J., *Spraying for scale insects*, *ibid.*, Bul. 166, pp. 21–23 (1905).
[26] Quayle, H. J., *Citrus fruit insects*, Calif. Agr. Exp. Sta., Bul. 214, p. 506 (1911).
[27] *Pacific Rural Press*, vol. 61, p. 51 (Jan. 26, 1901).
[28] Allen, R. C., *Pacific Rural Press*, vol. 63, p. 282 (Apr. 26, 1902).
Teague, C. C., *ibid.*, vol. 65, pp. 36–37 (Jan. 17, 1903).
Volck, W. H., *Spraying with distillates*, Calif. Agr. Expt. Sta., Bul. 153, 31 pp., 5 figs. (1903).

Process. It was simply a mixture of distillate oil of 24° Baumé with water. By vigorous agitation the oil and water were thoroughly mixed during the process of spraying. Later specially constructed power spraying machines were built whereby the mixing was effected at the nozzle.

A few years later it was discovered that the addition of lye or caustic soda made a much better and more effective spray.

The distillate-caustic soda-mechanical mixtures were generally used as dormant sprays for the control of black scale and brown

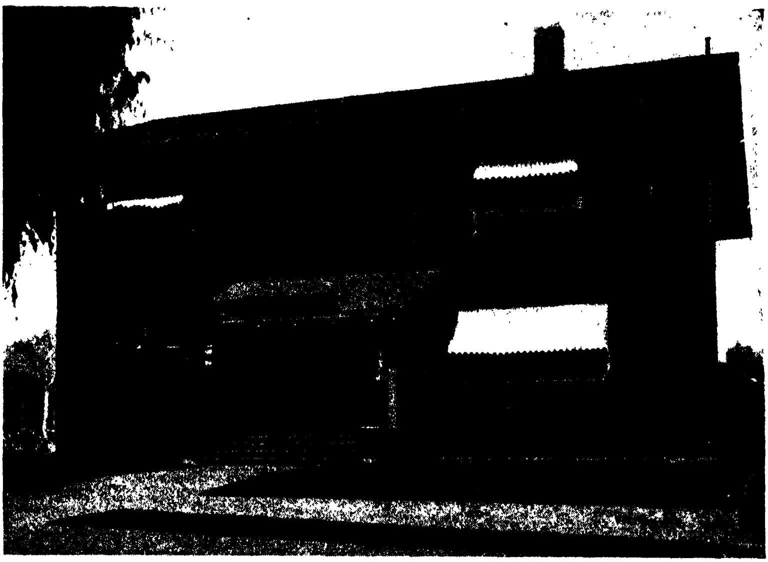

FIG. 127.—The Whittier Insectary was maintained by the California State Department of Agriculture from 1921 to 1923. At the latter date the biological control work was transferred to the University of California and headquarters were established at Riverside. (Photograph furnished by H. S. Smith.)

apricot scale on deciduous fruit trees of southern California prior to 1905. In that year H. J. Quayle conducted extensive experiments for the control of these two pests with distillates in southern California. At first a 3% straight distillate was used, but later caustic soda or lye was added and greatly improved the efficiency of the sprays. As a result of this work he suggested the following formula:[29]

[29] *Spraying for scale insects*, Calif. Agr. Expt. Sta., Bul. 166, p. 22 (1905).

Distillate oil (28° Baumé)	6 gallons
Potash or caustic soda	12 pounds
Water	200 gallons

The author used quantities of this material with much success for the control of these pests on apricot trees in Ventura County during the winter of 1910–1911,[30] without any apparent injuries to the trees. The formula used was:

Distillate (28° Baumé)	10 gallons
Caustic soda (95%)	7 pounds
Water	200 gallons

A power sprayer, with efficient agitator in the tank, was necessary to mix and apply this mixture.

The same formula is still in use to some extent today.[31]

A similar mechanical mixture of distillate and caustic soda was also recommended by P. R. Jones as a dormant spray for the control of the brown apricot scale and European pear scale in the Santa Clara Valley in 1910.[32] The formula used by him was more concentrated as the formula shows:

Distillate (28° Baumé)	6 gallons
Caustic soda	2 pounds
Water	90 gallons

Although distillate emulsions were used as sprays for citrus trees as early as 1900 and quite extensively in 1903, they were later replaced by the kerosene and water white oils for the control of citrus insects. The first emulsions were made according to the following formula:[33]

Soap	1 pound
Distillate	1 gallon
Water	30 gallons

Volck condemned this type of spray as unsatisfactory because of its unstableness and resultant injury to the fruit. This was no doubt largely due to the fact that the quality of the oils was variable and no standard type of a mixture could be obtained.

[30] Essig, E. O., Ventura Co., Hort. Commr., *Bul. 2* (1911).
[31] Horne, W. T., Essig, E. O., and Herms, W. B., *Plant disease and pest control*, Calif. Agr. Expt. Sta., Circ. 265, p. 111 (1927).
[32] U. S. Dept. Agr., Bur. Entom., *Bul. 80*, pt. viii, pp. 147–160, 2 figs., pl. xiii (1910).
[33] Volck, W. H., Calif. Agr. Expt. Sta., *Bul. 153*, p. 9 (1903).

In his recommendations for controlling scale insects in 1905, Quayle [34] does not include distillate emulsions.

Distillate emulsions, however, soon came into general use again as dormant sprays for deciduous fruit trees and gradually replaced the more caustic, mechanical mixtures with caustic soda. By 1910 they were in general use in most parts of the state. A formula which the author used in southern California in 1910–1911 and which gave excellent results without injury was as follows:

Distillate (28° Baumé)	20 gallons
Whale oil soap	30 pounds
Water to mix	12 gallons

Dissolve the soap in the twelve gallons of water, heating it to the boiling point; add the distillate and agitate thoroughly while the solution is hot. For use dilute one to twenty of water.[35]

Distillate emulsions continued to be used until they were largely replaced by proprietary oil sprays which appeared after 1918. The formulas for its preparation still appear in bulletins and books of reference but are seldom made and used by the orchardists.

Crude Oil Emulsions

Crude oil emulsions were first used in the Santa Clara Valley and were tested and reported upon by Paul R. Jones in connection with the control of the brown apricot scale and the European pear scale in 1909.[36] The formula used was:

Crude oil (16° to 22° Baumé) (direct from the wells)	12 gallons
Fish oil soap	10 pounds
Lye	2 "
Water	86 gallons

"About twenty gallons of the water were heated, and when this began to boil the dissolved soap and then the lye were added. This mixture was then removed to the tank, and the rest of the water (66 gallons) added, making 86 in all. The spray pump engine was then started and the crude oil slowly poured into the tank, the mixture being violently agitated by the tank agitator. A perfect emulsion resulted."

Crude oil emulsion was extensively used throughout California

[34] Quayle, H. J., *op. cit.*, 24 pp. (1905).
[35] Essig, E. O., Ventura Hort. Commr., *Bul. 2* (1911).
[36] U. S. Dept. Agr., Bur. Entom., *Bul. 80*, pt. viii, pp. 149–158 (1910).

as a dormant clean-up spray for scale insects, red spider eggs, leaf-roller eggs and other similar pests.

By 1918 the formula was changed somewhat to meet more general conditions and was as follows:[37]

Natural crude petroleum (21°–24° Baumé)	25 gallons
Liquid soap	3 "
Water	175 "

The success of this heavy spray at once caused the insecticide manufacturers to place similar proprietary brands on the market. These had the advantages over the homemade products, in having a constant supply of the same grades of crude oil and more efficient means of manufacture, with the result that the homemade emulsions were practically entirely replaced by these better materials after 1920.

Crude carbolic acid emulsion was apparently first used in this country by A. J. Cook in Michigan about 1870.[38] He used his regular formula for kerosene emulsion substituting the crude carbolic acid in five to seven parts of the soap emulsion. It was particularly recommended to scrub trees early in June for scale insects and to apply to the trunks of young trees during the spring and summer to repel the apple tree borers. In 1885 H. G. Hubbard used crude carbolic acid diluted with twice its volume of soap solution (two ounces of soap to one pint of hot water) for scale insects on orange trees in Florida.[39]

Carbolic lime, consisting of one hundred fifty pounds of quicklime, two gallons of crude carbolic acid, and two hundred gallons of water, was recommended for the control of pear thrips in California in 1911.[40]

The crude carbolic acid emulsion in California appears to have first been used by the writer for the control of the citrus mealybug, *Pseudococcus citri* (Risso), in Ventura County in 1910.[41] The formula used was:

[37] Smith, R. E., Essig, E. O., Gray, Geo. P., Calif. Agr. Expt. Sta., *Circ. 204*, p. 26 (1918).

[38] Mich. Agr. Expt. Sta., *Bul. 58*, p. 8 (1890).

[39] *Insects affecting the orange*, U. S. Dept. Agr., Div. Entom., p. 97 (1885).

[40] Quayle, H. J., *Insecticides and insect control*, Calif. Agr. Exp. Sta., Circ. 66, p. 3 (1911).

[41] Essig, E. O., *Spraying for the citrus mealy bug*, P. C. Jour. Entom., vol. 2, pp. 252–259 (1910).

Crude carbolic acid (commercial)	5 gallons
Whale oil soap	40 pounds
Water	40 gallons

The soap was dissolved in hot water, the crude carbolic acid added and the whole boiled for fifteen or twenty minutes. For use on citrus trees this stock solution was diluted one to twenty of water.

Since the above announcement this formula has been in limited but general use in many parts of the state. In 1921–1923 it was used to a considerable extent as a dormant spray for the control of the grape mealybug, *Pseudococcus maritimus* (Ehrh.), on pears in the Santa Clara Valley.[42] As a dormant spray five gallons of tree distillate, 27° Baumé, were added. This spray proved very satisfactory for the purpose.

In 1916, Gray [43] fully discussed the phenolic insecticides and fungicides after having examined one hundred and seventy-six commercial samples. These insecticides were used, up to that time, as washes for domestic animals infested with mange and scab mites, lice, and as general disinfectants.

The proprietary miscible oil sprays which have been on the markets in California since 1908 have largely eliminated the needs for a homemade emulsion of this sort.

Resin wash. This wash was first experimented with by Albert Kœbele in connection with the control of the cottony cushion scale, *Icerya purchasi* Maskell, in southern California in 1886. The formula used is given by C. V. Riley [44] as follows:

One pound of caustic soda is dissolved in one and one-half gallons of water; then the two pounds of resin and one pound of tallow are dissolved in one quart of the lye. After the resin is all well dissolved by moderate heat, the lye is added slowly while cooking under continued stirring; the mixture, if good, will become dark brown and thick. Should it become whitish and flocky (this is caused by too much and too strong lye), water should be added and it will become right again. This will make twenty-two pints of soap, for water should be added to make that amount, after the lye is in,

[42] Essig, E. O., Univ. Calif., College of Agr. and Agr. Expt. Sta., *Rept. for 1920–1921*, pp. 4–5 (1921); *Rept. for 1921–1922*, pp. 8–9 (1922); *Rept. for 1922–1923*, pp. 120–121 (1923).

[43] Gray, Geo. P., Calif. Agr. Expt. Sta., *Bul. 269*, pp. 329–381, 9 figs. (1916).

[44] U. S. Dept. Agr., *Rept. for 1886*, pp. 558–572 (1887).
State Bd. Hort. of Calif., *Bien. Rept. for 1885 and 1886*, p. 389 (1887).

at a cost of eleven cents, excluding labor and fuel in preparing it, which amounts to but little, and will be sufficient for forty-four gallons of wash sprayed well.

FIG. 128.—In 1916 H. S. Smith and E. J. Branigan established the fact that potato sprouts could be used for the artificial rearing of black scale and mealybugs and thus revolutionized insectary practices in California. In 1928, according to Smith, about 600,000 pounds of potatoes were used for this purpose in the state. The photograph shows trays of sprouts in proper condition for infestation; in fact the young mealybugs are plainly shown in great numbers upon the succulent food plants. The citrus mealybug is most desirable for this purpose, because it propagates more rapidly than any other species so far tried. (Photograph furnished by H. S. Smith.)

Another formula of the resin as successfully used for the control of the San José scale is:

Sixty pounds of resin, sixty pounds of tallow, ten pounds of commercial potash, dissolved in ten gallons of water; ten pounds of caustic soda (98 per cent), dissolved in ten gallons of water.

Dissolve the resin and tallow, add the caustic water slowly; after the mixture is made, add ten gallons of water. Proportion used, one gallon of mixture to ten gallons of water; use warm.

This spray proved to be a very good scalicide, particularly for soft brown scale and for black scale and was extensively used as a wash for young nursery citrus trees up until 1914. Apparently it caused no injury to either fruit or foliage and was perfectly safe to use on young trees. It was never extensively used as a spray in the deciduous fruit orchards. The various formulas used are:

	Resin (Pounds)	Caustic Soda (Pounds)	Tallow (Pounds)	Fish Oil	Water (Gallons)
A. Kœbele 1886	2	1	1		44
C. W. Woodworth 1894	18	$3\frac{1}{2}$		$2\frac{1}{2}$ pints	100
H. J. Quayle 1904	10	3		$1\frac{1}{2}$ pounds	50

In 1907–1908 resin wash was recommended by H. J. Quayle [45] for the control of the grape leafhopper, but was never generally used for this purpose.

Miscible Oils

The discovery and manufacture of miscible oils (in America) for the control of insect pests came about in a very unusual and interesting manner. Through the kindness of R. H. Smith, I received a copy of a letter describing it by the originator, B. G. Pratt, New York City, under date of October 25, 1929.

In 1891 Mr. Pratt had about twenty apple trees at Merchantville, New Jersey, all of which were killed by the San José scale. This caused him to look with interest into the methods of dealing with pests. He investigated the various sprays used at that time and soon became familiar with the recommendations of John B. Smith, A. J. Cook, S. A. Forbes and others. He states:

From 1887 to 1900 I was engaged in the manufacture of soap. About this time, I became interested in the manufacture of cutting compounds for machine shops. The most satisfactory material on the market was a preparation imported from Germany known as "Lubria," which was a miscible oil. I spent a good deal of time visiting libraries, and in the laboratory, trying to duplicate this, which I finally succeeded in doing and sold it under the name of Hydro-

[45] *Calif. Agr. Exp. Sta. Bul. 198*, p. 209 (1908).

leine. We found that this conflicted with some previous trade-marked name, and afterwards changed it to Hydroil, which we still manufacture.

In the spring or summer of 1904, a friend of mine wrote to Dr. John B. Smith, State Entomologist of New Jersey, asking if a soap could be made that would carry sufficient kerosene to be of value in controlling scale. He replied, no, but that if he had an oil that would readily mix with water, he

FIG. 129.—A tray of potato sprouts showing advance stages of mealybug infestation. The larvæ of the ladybird beetles and parasites find ideal feeding conditions provided for them in the insectaries. (Photograph by H. S. Smith.)

believed it would be a good scale control. I told him that I could supply this, and made a sample, which was sent to Dr. Smith.

A few days later, Dr. Smith called on me in New York and explained the situation. He was very much interested and sent a barrel of oil which he had on hand to our laboratory, which we rendered water-miscible, and sent it back to him. This he distributed to a number of growers in New Jersey, and it was an instant success.

I did not know it, but it seems that about this time there appeared on the market a preparation known as Kil-o-scale made by the Thompson Chemical Company of Baltimore, and distributed by the Griffith Turner Company. It was very similar to Scalecide except that there was a small percentage of free sulfur in this material, and it sold at $1.00 per gallon in barrels. This was the work of a German chemist. I do not recall his name just now. At one time he accused me of duplicating his goods. I satisfied him that we had manufactured water-miscible petroleum oils long before he ever came to this country. (Miscible oils were also previously known in England.)

Of course, one of the first things that Dr. Smith wanted to know was the

cost. We told him that if we could manufacture it at a close enough price to compete with lime-sulfur, we would undertake to make it, but otherwise we were not interested, and so from then until the second year of the war, Scalecide sold at 50c. per gallon delivered anywhere east of the Mississippi River.

The success with Scalecide was almost immediate, and in a short time practically superseded, at least in the east, the homemade lime-sulfur which had

FIG. 130.—Rear view of the Orange County Insectary, the largest establishment of its kind in the world. In addition to the office there are twenty-two separate units for rearing the beneficial insects. (Photograph taken April 17, 1930.)

been boiled at home and applied hot. This success started a dozen different brands of oil sprays on the market. Some of them good, but the great majority were of doubtful stability, and often caused injury, helping to verify the prediction of some of our entomologists that while Scalecide might control scale, it eventually would kill the trees, and in many places, all oil sprays were wrongfully called Scalecide.

In 1907 Professor Jarvis [46] of Connecticut and Professor Penny [47] of Delaware, spent a great deal of time in working out a formula for homemade miscible oils, and issued bulletins on them. The formula consisted of carbolic acid and soap used as an emulsifier for petroleum oil, and was a formula which we had worked out when we were working on cutting compounds, and discarded because no self-respecting mechanic would use a cutting compound that smelled of carbolic acid and clung to his clothing at home as well as at work. In fact, we used amyl-acetate in our Hydroil to give it a pleasant odor.

[46] Jarvis, C. D., *Petroleum emulsion for the San José scale*, Conn. Storrs Agr. Exp. Sta., Bul. 49, 12 pp. (1907).

[47] Penny, C. L., *Some practical directions for making oil emulsions*, Del. Agr. Exp. Sta., Circ. 1, 6 pp. (1907).

Homemade miscible oils, *ibid.*, Bul. 79, pp. 1–34, 2 figs. (1907).

Miscible oils: How to make them, Pa. Agr. Exp. Sta., Bul. 86, 20 pp., 1 fig. (1908).

Of course, these recommendations of Professors Jarvis and Penny were taken up by various experiment stations,[48] and the fruit growers instructed how to make it, but this part was a failure. However, it did give a number of the manufacturers a better formula than they had before, and is still on the market under various names, selling generally as close to the price of Scalecide as possible. To meet this competition, we put out Carboleine, publishing the formula for its manufacture on the label on the barrel, and selling it at $15.00 per barrel, or 30c. per gallon as against 50c. per gallon for Scalecide.

Following the appearance of the first miscible oil many kinds soon flooded the markets and spray manufacturing companies

FIG. 131.—One of the units of the Orange County Insectary. In 1928 this insectary produced 20,876,460 adults of the mealybug destroyer, *Cryptolæmus montrousieri* Muls., which were liberated in the citrus orchards of the county for the control of mealybugs. (Photograph furnished by D. W. Tubbs, 1928.)

sprang into being in all parts of the country, beginning about 1904, and formulas for homemade mixtures were many. The first oils used were the kerosene and distillate types, other materials such as soap, phenols, etc., were added as emulsifiers. By 1914 the commercial preparations almost entirely replaced the homemade products.

[48] Parrott, P. J., Hodgkiss, H. E., and Sirrine, F. A., *Commercial miscible oils for treatment of the San José scale*, N. Y. Agr. Exp. Sta., Bul. 281, pp. 261–270 (1907).
Hall, F. H., *Miscible oil sprays*, *ibid.*, Bul. 281, pop. ed., 7 pp., 1 fig. (1907).
Craig, C. E., *Patent washes for San José scale*, Va. Crop Pest Com., Circ. 2 n. s., 11 pp. (1907).
Gossard, H. A., *Soluble oils as destroyers of San José scale*, Ohio Agr. Exp. Sta., Circ. 60, 4 pp. (1907).
De Ong, E. R., *Soaps and miscible oils*, Calif. State Hort. Com., Mthly. Bul., vol. 5, pp. 172–176 (1915).
Gray, Geo. P., *Standard insecticides and fungicides*, versus *secret preparations*, Calif. Agr. Exp. Sta., Circ. 141, 4 pp. (1915).
Phenolic insecticides and fungicides, *ibid.*, Bul. 269, pp. 329–381, 9 figs. (1916).

Highly Refined Oil Emulsions

In 1915 and 1916 George P. Gray and E. R. de Ong of the insecticide laboratory of the University of California carried out experiments with many different kinds of oils and made one of the most important discoveries in the entire history of oil sprays, namely, that the unsaturated hydrocarbons are the elements chiefly responsible for injury to plants by spray oils, and that the safest oils are those most highly refined by treatment with sulfuric acid.

The history [49] of the development of oil sprays since then is most interesting and encouraging. The highly refined oils, at present generally used in the spraying of citrus trees and other trees in foliage, are specified chiefly according to viscosity and unsulfonated residue, the former ranging from 50 to 110 seconds Saybolt and the latter usually well above 80 per cent. The oils are made into emulsions composed of the oil, water and calcium caseinate or similar substance as an emulsifier. In practice these new oil sprays give a minimum amount of damage to fruit and foliage, but they are injurious under certain conditions and must be used judiciously.

Suggestions for Use of Oil Sprays in 1930

The members of the Western Coöperative Oil Spray Project, comprising the experimental stations of California, Idaho, Montana, Oregon, Washington and British Columbia, and the United States Department of Agriculture, made the following suggestions regarding the use of oil sprays on fruit trees in the Northwest, with particular reference to apples and pears. These suggestions were based on data accumulated from experimental work during the years, 1927, 1928 and 1929.

[49] De Ong, E. R., *Spraying citrus orchards with oil*, Calif. Cult., vol. 49, pp. 27, 28 (July 14, 1917).

Experimental studies in the use of petroleum oils and insecticides on citrus and deciduous trees, Am. Petroleum Inst. Bul., no. 27, pp. 171–196 (Apr., 1926).

Technical aspects of petroleum oil sprays, Jour. Econ. Entom., vol. 19, pp. 733–744 (1926).

Quayle, H. J., *Scale control on citrus trees*, Calif. State Hort. Com., Proc. 47th Fruit Growers' Conv., pp. 222–224 (1915); *Calif. Cult.*, vol. 48, p. 4 (Jan. 6, 1917).

Vickery, R. K., *Petroleum insecticides*, Jour. Econ. Entom., vol. 13, pp. 444–447 (1920).

De Ong, E. R., and Gray, Geo. P., *California petroleum insecticides*, Jour. Indust. and Engin. Chem., vol. 18, p. 175 (1926).

De Ong, E. R., Knight, H., and Chamberlin, J. C., *A preliminary study of petroleum oil as an insecticide for citrus trees*, Hilgardia, vol. 2, pp. 351–384 (1927).

Smith, R. H., *Highly refined oil emulsions*, Calif. Citrograph, vol. 13, pp. 358, 376–377, 388 (Aug., 1928).

Studies on spray tank agitation in the use of oil sprays, Jour. Econ. Entom., vol. 29, pp. 929–934 (1929).

The author is indebted to Ralph H. Smith for help in the final preparation of the material on this particular subject.

Oils for dormant sprays

1. Dormant oil sprays should be applied in the spring before the bud scales separate and before the buds show green. Injury may result if sprays are applied during the critical period (delayed dormant) of bud development. This period occurs between the time the buds first show green and the cluster bud stage.

2. There is no evidence that low temperatures following sprays applied in the spring during the dormant period result in injury.

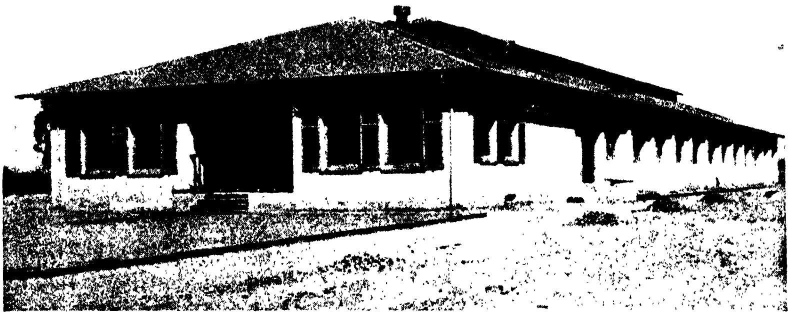

FIG. 132.—The new Los Angeles County Insectary built at Riviera in 1929. It is a splendid modern semifireproof building 200 feet long and containing 24 production rooms, each 12 x 18 x 8 feet and each with a capacity of 360 trays of host plant material and a productive capacity of approximately 150,000 ladybird beetles each five-months period. In the front are office and laboratory rooms. (Photograph and information furnished by H. M. Armitage, the superintendent.)

3. Oils of relatively low sulfonation test (50–70) can be safely used.
4. Stable emulsions have proven safer than quick breaking emulsions.

Oils for summer sprays

The following suggestions are made to growers who are planning on using oil sprays for codling moth control.

1. The number of applications of summer oils should not exceed three, and under most conditions not more than two are advisable.

2. The use of oils alone has not given control of the codling moth. Oils should be used only in combination with lead arsenate or nicotine sulfate.

3. Oils in combination with lead arsenate should be applied during the height of the egg-laying period of the first brood, but if sulfur sprays are applied after the dormant period, no oil should be used in the first brood sprays.

4. Because of difficulty in removing spray residue, the oil-lead arsenate combination should not be used after July 25, but the oil-nicotine sulfate combination may be used after this date.

5. Oils ranging in viscosity from 65–75 have proven most satisfactory, ex-

cept that for Newtons or other varieties susceptible to oil injury the viscosity of the oil should not exceed 55.

6. Oils with a sulfonation test not less than 85 are satisfactory.

7. Caution: Oils in combination with lead arsenate should not be allowed to stand in pipes or spray tanks, but should be applied immediately after being mixed. Fruit sprayed with this combination after the spray has been allowed to stand in tanks or pipes for some time, can be cleaned only with great difficulty. This spray mixture is also ineffective in control.

8. For more specific recommendations regarding the use of oil, local authorities should be consulted.

Arsenical Sprays

Paris green, a cupric aceto-arsenite of a bright green powder prepared from white arsenic and acetate of copper, was generally used throughout this country as a pigment for making green paints, particularly for window shutters. It is related that a certain farmer after painting the window shutters, threw the remaining green paint on some potato plants badly infested with the Colorado potato beetle, and to his surprise these plants were soon freed of the pest and thus it became known that Paris green had insecticidal properties.[50]

According to Lodeman,[51] "Paris green appeared upon the scene sometime between 1860 and 1870. The use of this deadly poison may have originated with several persons; for some poison of this nature was evidently needed to destroy such a voracious feeder (the Colorado potato beetle). The use of Paris green as a standard insecticide undoubtedly began in the Western States (Mississippi Valley), and there the applications to the vines were considered as of primary importance in securing a crop. The use of the poison was, to a limited extent, checked by the possible dangers connected with its careless handling. It is also very injurious to foliage, when applied pure, especially in large quantities, and this may have exerted a certain influence in preventing its general adoption. But the weight of these objections was soon overcome by the absolute necessity of treating the vines in order to save them."

In 1867, C. V. Riley conducted experiments in Missouri in controlling this beetle and reported that "white hellebore, Paris green, slaked lime, etc., etc., I have proved by experiment to be valueless, though the two first will kill, if thoroughly applied, a certain portion of the larvæ, but will not affect the beetles." [52] In this same year, Byron Markham,[53] Michigan, claims to have used Paris green for

[50] There appears to be no authentic record to support this rumor.

[51] Lodeman, E. G., *The spraying of plants* (New York, Macmillan, 1897), pp. 60–61.

[52] State Entom. of Missouri, *First Ann. Rept.*, 1868, p. 116 (1869).

[53] *Insect Life*, vol. 5, p. 44 (1892).

poisoning the Colorado potato beetle and the next year, 1868, successful experiments in the control of the same pest with a mixture of one pound of Paris green to two pounds of flour were conducted by Geo. Liddle, Sr., Illinois.[54] In referring to the work of Liddle, B. D. Walsh and C. V. Riley, editors of the American Entomologist, state: "We can confidently recommend the above

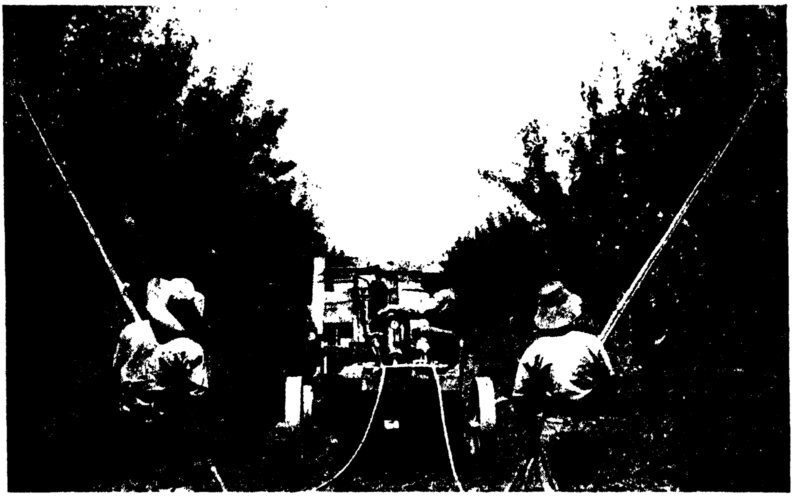

FIG. 133.—A power sprayer used in applying Paris green for the control of the codling moth in the Pajaro Valley, California, in 1904. The first spray rod consisted of a small gas pipe bound to a bamboo pole as illustrated.

remedy (Paris green and flour) as the most effectual and probably the cheapest yet known. Last year we tried Paris green and ashes—one part of the green to five of ashes—and though it killed most of the larvæ it did not seem to affect the parent beetles. But we are inclined to believe that the Paris green we used was not of good quality; for experiments the present year according to the above directions have been highly satisfactory." In 1870 Riley also reports: "This substance (Paris green) has now become *the* remedy for the Colorado potato beetle, and it is the best yet discovered. Having thoroughly tested it ourselves, and having seen it extensively used we can freely say that, when applied judiciously, it is efficient and harmless." [55] At this time he recommended one part to from six to twelve parts of flour, ashes, plaster, or slaked lime. It was to

[54] *Am. Entomologist*, vol. 1, p. 219 (July, 1869).
[55] Entom. of Missouri, *Third Ann. Rept.*, 1870, pp. 99–100 (1871).

be applied with a shaker. The quality of the material was uncertain and considerable damage often resulted to the treated plants. There were also many prejudices against using the material for fear of poisoning the plants and tubers and ruining the quality of the latter. In 1871 Riley attempted by experimentation to disprove these absurd theories.[56]

As early as 1868 a patent was taken out by James P. Wilson of Illinois for the use of one part of Paris green to two parts of mineral paint to kill potato bugs.[57]

The material was first applied as a dust, and later on, as either a dust or a spray. A sprinkler was used for the latter, which was modified from time to time until in 1874, Gray's Improved Sprinkler enabled the operator to carry a tank on his back and apply the spray through two short pieces of hose, each fitted with a sprinkler, thus permitting the treatment of two rows at one time.[58]

According to Lodeman,[59] William LeBaron, State Entomologist of Illinois, in 1872, recommended the use of Paris green against the spring cankerworm, which was abundant that year, which appears to be the first recommendation for its application to fruit trees. In the summer of 1878 J. S. Woodward of Lockport, N. Y., was the first to recommend Paris green as a specific against the codling moth. A. J. Cook [60] advised its use for the control of cankerworms in Michigan the same year.

In 1880 Cook, after experimenting with Paris green to control codling moth, recommended it as an apple spray to control this pest. He called attention to two facts: " First, that Paris green was efficient as a preventive of the ravages of the codling larva; and secondly, that such use was entirely safe in respect to poisoning the fruit." He recommended one pound to fifty gallons of water.[61] He became the most ardent advocate of this treatment for codling moth.[62]

[56] *Ibid., Fourth Ann. Rept.*, 1871, pp. 11–14 (1872).

[57] Riley, C. V., Missouri State Entom., *Sixth Rept.*, p. 20 (1874).

[58] Riley, C. V., Missouri State Entom., *Seventh Rept.*, p. 15 (1875).

[59] Lodeman, E. G., *op. cit.*, pp. 61–63.

Spraying with arsenical mixtures, U. S. Dept. Agr., Yearbook, 1887, pp. 103–115 (1888).

Howard, L. O., *Progress in economic entomology, ibid.*, Yearbook, 1899, p. 147 (1900).

[60] *Rept. Mich. Pom. Soc.*, p. 43 (1876); p. 236 (1878).

Insect Life, vol. 4, p. 62 (1891).

[61] *Rept. Mich. Pom. Soc.*, pp. 26, 136 (1880); p. 130 (1881).

Mich. Agr. College, *Bul. 53*, p. 3 (1889).

[62] Howard, L. O., *op. cit.*, p. 148 (1900).

Howard further states: "The careful experiments made by Forbes[63] in 1885 added great weight to the remedy, on account of his wide reputation for care and conservatism. E. S. Goff,[64] then at Geneva, N. Y., also published results of some careful experiments made in 1885. In 1887 experiments made by W. B. Alwood and E. H. Cushman for the Division of Entomology emphasized the value of the treatment, which the writer did not hesitate to strongly recommend in his article on the codling moth, published that year."[65]

In 1888 Cook recommended from three-fourths to one pound to one hundred gallons of water and stated that, "the important thing is to scatter the spray on all the fruit, and get just as little on as possible." The spray was applied with Whiteman's Fountain Pump (a syringe pump) and a pail, or with a force pump mounted on a barrel.[66]

In 1882 Paris green was successfully used for the control of the cotton worm, *Alabama argillacea* (Hbn.) [*Aletia xylina* (Say)] in the southern states. It was sifted dry or sprayed or syringed on the plants at the rate of one pound to forty gallons of water.[67]

In 1883 Matthew Cooke, former chief executive horticultural officer of California, recommended the use of both Paris green and London purple "by dusting around the stems of trees and plants so that cutworms or caterpillars will have to pass over it; by licking their feet they are poisoned. I have also found that it has the same effect on beetles (and cockroaches), where it gets upon their feet, antennæ, etc.; by cleaning it off their feet, mandibles, etc., it poisons them. London purple (and also Paris green) should not be used in the summer season on fruits or vegetables used for food, at least in California where there are no rains to wash it off."[68] He did not recommend either for the control of the codling moth. In 1887 E. J. Wickson[69] conducted some experiments for the control of the

[63] Forbes, S. A., *Experiments on the codling moth and curculios*, Miscl. essays on economic entomology by the state entomologist and his assistants, bound with Ill. Dept. Agr., Trans., 1885, vol. 23, pp. 26–45 (1886).
Howard, L. O., U. S. Dept. Agr., *Yearbook*, 1887, p. 106 (1888).

[64] N. Y. Agr. Expt. Sta., Geneva, Board of Control, *4th Ann. Rept.*, 1885, pp. 216–220 (1886).
Howard, L. O., U. S. Dept. Agr., *Yearbook*, 1887, p. 106 (1888).

[65] Howard, L. O., U. S. Dept. Agr., *Yearbook*, 1887, pp. 109–115 (1888).

[66] Mich. Agr. College, *Bul. 14*, pp. 5–6 (1888).

[67] U. S. Commr. Agr., *Rept. for 1881–1882*, pp. 158–159 (1882).

[68] Matthew Cooke, *Injurious insects of the orchard, vineyard, etc.* (Sacramento, H. S. Crocker & Co., 1883), pp. 402, 420.

[69] *Spray and band treatment of codling moth*, Calif. Agr. Expt. Sta., Bul. 75 (1887).

codling moth with various arsenicals. In these tests, which were under the immediate direction of W. G. Klee, Paris green was used, one pound to one hundred and sixty gallons of water, the same mixture with two pounds of soap, and one pound to three hundred and twenty gallons of water. No important results were recorded.

Although Paris green was first recommended for the control of the plum curculio by G. M. Smith,[70] Berlin, Wisconsin, in 1871, and used with good results by J. L. Bowers, Herndon, Va., in 1880, it was not generally accepted as a remedy for this insect until after the work of Forbes in 1885, W. B. Alwood and Herbert Osborn of the Division of Entomology, A. J. Cook, Michigan, and C. M. Weed, Ohio, in 1887. By this time it was generally accepted as a standard remedy for all leaf and fruit eating insects.

Alexander Craw[71] in 1895 presented a paper on the value of Paris green as an insecticide before the State Fruit Growers Convention, at Sacramento, California, November 7, 1895, in which he discussed the reasons for its occasional failure and summarized by stating: "Purchase Paris green from a reliable house. Do not buy cheap grades. Add lime water to the solution. Keep it constantly stirred when spraying. Be careful in applying: spray at the proper time, and the result will be sound crops and trees free from caterpillars."

C. W. Woodworth and Geo. E. Colby in a bulletin[72] published in 1899 state that "Paris green is practically the only substance that has been widely and extensively used as a remedy for the codling moth." They gave methods for determining the adulteration of Paris green, causes of injury to the foliage and a method of preventing the injuries by adding ten parts of lime to one part of the poison. Up to this time it was applied almost entirely as a spray. In 1894 Woodworth recommended dusting one to five pounds per acre by means of a muslin bag on the end of a pole or spraying with one pound to two hundred gallons of water.

About this time also Taft and Kedzie of the Michigan Agricultural College made known the formulæ for the preparation of homemade arsenite of lime, which when properly mixed gave

[70] Howard, L. O., *op. cit.*, p. 148 (1900).

[71] *Paris green as an insecticide*, State Bd. Hort., Calif., Rept. Nineteenth Fruit Growers' Convention, pp. 74–76 (1895).

[72] *Paris green for the codling moth*, Calif. Agr. Expt. Sta., Bul. 126, 40 pp., 2 figs. (1899).

Woodworth, C. W., *Substitutes for Paris green*, State Bd. Hort., Rept. of twenty-fourth State Fruit-Growers' Convention, pp. 90–96 (1899).

much more satisfactory results with less injury to the plants than was possible with Paris green. (See white arsenic, p. 431.)

In 1903 Geo. E. Colby fully discussed arsenical insecticides[73] in the light of the insecticide law which was passed in 1901 and which fixed the minimum amount of arsenious oxide at 50% and the maximum quantity of white or soluble arsenic in Paris green for insecticide purposes at 4%. He stated that from 1,500 to 2,000 tons of Paris green were used annually in the United States for insect pest control. In 1904 Woodworth called attention to the fact that while Paris green was highly satisfactory, in the interior valleys of the state, that it was often very injurious in the fog belt area, where it was replaced by arsenite of lime or arsenate of lead.[74] He also recommended a new spray mixture composed of

Paris green	1 pound
Crude oil (petroleum)	1 pint
Slaked lime	4 or 5 pounds

Dilute to 100 gallons of spray material.

This mixture was claimed to be safe, because the particles of Paris green were coated with oil and therefore could not injure the foliage. This work was continued in the Pajaro Valley in 1905 by W. H. Volck,[75] who recommended:

1. That Paris green be discarded in all sections where its careful use had resulted in injury to trees.
2. That arsenate of lead, since it has been found reliable and non-injurious to vegetation, be generally used.
3. That commercial arsenate of lead be used in preference to the home-made products.

By 1906 Paris green as a general insecticide, except for poison baits, was almost entirely replaced by arsenate of lead and similar safer arsenical compounds. However, as late as 1922, a prominent apple orchardist at Alviso, Santa Clara County, used four pounds of Paris green and eight pounds of slaked lime to two hundred gallons of water for the first or calyx spray for codling moth on apples, with good success and without serious injury, although he lives within the fog belt area.

[73] Calif. Agr. Expt. Sta., *Bul. 151*, 38 pp., 10 figs. (1903).
[74] *Directions for spraying for the codling moth*, Calif. Agr. Expt. Sta., Bul. **155**, 20 pp., 5 figs. (1904).
[75] *Practical suggestions for codling moth control in the Pajaro Valley*, Calif. Agr. Expt. Sta., Circ. 14, 11 pp., 1 fig. (1905).

London Purple

London purple [76] is a purple powder obtained as a by-product in the manufacture of aniline dyes and is composed mostly of arsenite of lime. It was introduced into America through the courtesy of Hemingway and Co. of London, England, who shipped three kegs to C. E. Bessey, Ames, Iowa, for trial experiments. The material reached its destination the last of February, 1878, and the first experiments with this poison were conducted by Bessey in the control of the Colorado potato beetle.[77] He is responsible for the name London purple. It therefore came into use somewhat later than Paris green, but shared similar developments and uses. The variable amounts of arsenic it contained rendered its use very uncertain and often resulted in serious injuries to the treated plants. It was generally considered more toxic to insects and therefore used in smaller quantities than Paris green, but inasmuch as the price was higher, it was on practically the same basis as Paris green. The first extensive successful experiments with London purple were conducted by J. L. Budd and C. E. Bessey at the Iowa State Agricultural College in 1878 for the control of the Colorado potato beetle.[78]

In the winter of 1878–1879, C. V. Riley directed his various agents in the south to test this material for the control of cotton worms. E. A. Schwarz conducted a number of experiments in Texas using dry and wet applications. As a result of this work Riley recommended the use of one-half pound of the powder to from fifty to fifty-five gallons of water with a little flour to give the spray adhesiveness.[79] In 1879 it was also successfully used for cankerworms in Illinois. A. J. Cook, in Michigan, recommended either Paris green or London purple for the control of the codling moth in 1881 [80] at the rate of from three-fourths to one pound to one hundred gallons of water. However, he appeared to prefer Paris green. For many years afterwards there were strong advocates of both of these materials. In California, E. J. Wickson and W. G. Klee experimented with both for the control of the codling moth in

[76] Lodeman, E. G., *The spraying of plants* (New York, Macmillan, 1897), pp. 65–68.

[77] Bessey, C. E., *The College Quarterly*, Iowa Agr. College, Ames, Iowa, vol. 1, no. 3, p. 49 (Sept., 1878).

Lodeman, E. G., *op. cit.*, pp. 65–67.

[78] Riley, C. V., U. S. Entom. Comm., *Rept. 4*, p. 149 (1885).

[79] Riley, C. V., *op. cit.*, pp. 149–153 (1885).

[80] Mich. Agr. College, *Bul. 14*, pp. 5–6 (1888).

1887, and, while they were both considered satisfactory, no important results were obtained with either.[81] In 1889 S. A. Forbes of

FIG. 134.—Arsenical injury to apple leaf caused by the application of Paris green. This was a common type of injury before the better grades of arsenate of lead were used. (Photograph taken in 1903.)

Illinois stated that "from our present knowledge of the use of arsenites as insecticides they cannot be recommended for use on the peach." [82] In 1894 both were recommended by C. W. Woodworth

[81] Calif. Agr. Expt. Sta., *Bul. 75* (1887).
[82] *Insect Life*, vol. 2, p. 182 (1889).

for general purposes to be applied either dry, in a muslin bag on a pole at the rate of from one to five pounds per acre, or as a spray using one pound to two hundred gallons of water.

London purple fell into the discard many years earlier than did Paris green. This was largely due to its more injurious effects on the foliage and fruit of the plants treated. When arsenate of lead came into general use in 1906, London purple had long been forgotten as a commercial insecticide.

White Arsenic

White arsenic [83] was one of the most important of the early poisonous insecticides and was used alone or as a basis for other compounds. The pure material (As_2O_3) is a heavy white powder slowly soluble in water. In 1848 an Englishman, George Gordon [84] mixed it with sugar to kill ants. In the United States it was early tried for the Colorado potato beetle, but because of the injury to the potato plants, it was replaced by Paris green.[85] In 1889, A. J. Cook published the results of a careful study to determine the relative toxicity to plants of Paris green, London purple, and white arsenic. His conclusions were: "London purple is more injurious to the foliage than is Paris green; and white arsenic—arsenious acid—is more harmful than is either London purple or Paris green." [86] Alone it has long been used as the poison element in baits for grasshoppers, cutworms, and other foliage-eating pests. In combination with lime and with sal soda it forms arsenite of lime, a product not greatly different from London purple, but apparently less toxic to fruit and foliage. S. F. Chapin recommended one pound of arsenic to one hundred and fifty gallons of water for the control of cankerworms in 1883 [87] and in the same year Matthew Cooke [88] advocated the use of white arsenic at the rate of six pounds dissolved in sixty gallons of hot water and an additional amount of water to make one hundred and fifty gallons in all (one or two pounds of potash were also used to hasten the dissolving of the arsenic) for cankerworms, beetles and other leaf-eating insects. One pound of whale oil soap to every ten gallons of spray was also suggested where plants were severely infested with such insects.

[83] Lodeman, E. G., *The spraying of plants* (New York, Macmillan, 1897), pp. 75–77.
[84] *Jour. London Hort. Soc.*, vol. 4, p. 19 (1848).
[85] Saunders, W., and Reed, E. B., *Can. Entom.*, vol. 3, pp. 41–51 (July, 1871).
[86] Mich. Agr. Expt. Sta., *Bul. 53* (1889).
[87] State Bd. Hort., Calif., *Ann. Rept.*, p. 134 (1883).
[88] *Injurious insects of the orchard, vineyard, etc.*, pp. 373, 400 (1883).

Growers were cautioned not to apply this spray on trees with fruit to be consumed later.

In the use of Paris green and London purple for spraying various plants, and particularly fruit trees, considerable loss was occasioned by the injuries caused by these chemicals. To overcome these disadvantages, C. P. Gillette conducted experiments in Iowa in 1889–1890 which showed that the addition of lime to either Paris green or London purple rendered them less injurious to the foliage, but caused the opposite effect with white arsenic.[89] In 1890 B. W. Kilgore in North Carolina, conducted chemical experiments along the same lines and discovered that a cheap arsenite could be obtained by boiling together for one-half hour, one pound of white arsenic, two pounds of lime in from two to five gallons of water, which was further diluted with water to make one hundred gallons of spray.[90]

L. R. Taft and R. C. Kedzie of Michigan saw the value of Kilgore's discovery and adapted it to the needs of the orchardists and farmers of the country. With some modifications they each issued a separate formula which was first announced in print by Taft[91] and which came to be known as the Taft and Kedzie formulas. They were as follows:

Taft formula—arsenic and lime

White arsenic	1 pound
Quicklime	2 pounds
Water	2 gallons

Boil together for forty minutes and dilute with water to make four hundred gallons of spray material.

Kedzie formula—arsenic, sal soda, and lime

		Later formula
White arsenic	$1\frac{1}{2}$ ounces	2 pounds
Sal soda	5 ounces	4 "
Water	1 gallon	2 gallons

Boil together for fifteen to twenty minutes or until dissolved; add two pounds of quicklime and dilute to make forty gallons of spray.[92] The later formula was diluted one pint to forty gallons of water.

[89] Iowa Agr. Exp. Sta., *Bul. 10*, pp. 401–420 (1890).

[90] Kilgore, B. W., *The injury of foliage by arsenites; a cheap arsenite; combination of arsenites and fungicides*, N. C. Agr. Exp. Sta., Bul. 77b (Tech. Bul. 2), 11 pp. (July 1, 1891).

[91] Mich. Agr. Exp. Sta., *Bul. 124*, p. 46 (Apr., 1895).

[92] The formulas as given by letter to C. W. Woodworth are somewhat different. Woodworth, C. W., and Colby, Geo. E., Calif. Agr. Exp. Sta., *Bul. 126*, pp. 22–25 (1899).

Both of these formulas were varied to meet the conditions of a particular locality and in many places twice or three times as much lime was required to insure against injuring the foliage.

In the West these formulas appear to have first been used in Oregon and Washington prior to 1899, at which time they were suggested to the growers of California by Woodworth. However they seem to have had little or no use in this state.

Although these homemade compounds served a very useful purpose, they were soon replaced by the more reliable and less troublesome proprietary compounds of arsenate of lead about 1906.

White arsenic is still used in considerable quantities in the preparation of poison baits for grasshoppers, cutworms, sowbugs, and snails.

Arsenate of Lead

Arsenate of lead was first proposed as an insecticide in 1892 by F. C. Moulton [93] in experiments to control the caterpillars of the gypsy moth, without injuring the foliage as was the case in using Paris green and London purple. His experiments in 1891 and 1892, were later continued along similar lines by A. H. Kirkland, F. J. Smith, and A. F. Burgess, under the direction of C. H. Fernald of the Massachusetts Agricultural College.[94]

A large number of experiments were made, using different formulas, which demonstrated the practical effectiveness of the poison and the proper method of its preparation. The poison, as used at that time, was made by dissolving the proper amounts of arsenate of soda and acetate of lead salts in separate vessels containing water. These solutions were then brought together and a precipitate, consisting of arsenate of lead was formed. Usually the fresh precipitate was prepared in the field. The material as first made, and used for many years afterwards, is known as acid or plumbic form, $PbHAsO_4$ and was prepared as a paste, which, by agitation would remain suspended in water while it was being applied as a spray. It could be sprayed upon the tenderest foliage, a dilution of ten pounds to one hundred gallons of water without injury, whereas one pound of Paris green to one hundred gallons of water frequently injures the leaves.[95]

The use of this newly discovered insecticide, however, was not at all rapid and was given a setback on the perfection of arsenite of

[93] Fernald, C. H., Hatch Expt. Sta. of Mass., *Bul. 24*, pp. 1–7 (1894). "This substance was first proposed as an insecticide by Mr. F. C. Moulton, in 1892, while acting as chemist in Malden, under Mr. E. H. Forbush, Field Director, in charge of the work of destroying the gypsy moth."

[94] Rogers, D. M., and Burgess, A. F., *Report on the field work against the gipsy moth and the brown-tail moth*, U. S. Dept. Agr., Bur. Entom., Bul. 87, p. 17 (1910).

[95] Howard, L. O., U. S. Dept. Agr., Bur. Entom., *Bul. 11*, n. s., p. 15 (1897).

lime as an insecticide by the work of Taft and Kedzie of Michigan in 1895.

In 1889 arsenate of lead had been tried in a number of states. M. V. Slingerland of New York writes: "The arsenate of lead is being quite extensively used in Albany and possibly in some other places in Hudson River Valley for the elm-leaf beetle. I do not know that anyone has used the arsenate of lead in this state for the codling moth." [96] It was being used for the control of the codling moth in Connecticut and New Jersey at that time.

In 1903 there were several kinds of commercially prepared arsenate of lead in the markets of California in powder or paste form. Colby,[97] at the University of California, published in that year two methods of making it at home—"either by mixing the ordinary acetate of lead (sugar of lead), or the more expensive nitrate of lead with the best quality of arsenate of soda. The formula for making one pound of lead arsenate, i.e., enough for from one hundred to one hundred fifty gallons of water, is to dissolve twenty-four ounces of acetate of lead (or twenty ounces of lead nitrate) in one gallon of cold water; also separately, ten ounces of arsenate of soda in three quarts of water; both in wooden vessels. These weighed quantities can be bought in separate parcels and are superior to any mixture of them which may be offered. The separate solutions are to be poured together into the spray tank filled with water. A white precipitate of lead arsenate ready for spraying immediately forms in the tank; its fine flocculent condition keeps it in suspension for hours, and of all arsenicals it is the most easily kept suspended in water." The preparation was recommended as strong as from three to fifteen pounds to one hundred gallons of water, "without the least danger of producing any injury to foliage." At this time "Swift's arsenate of lead," in the form of paste, was available in the markets as was also another brand, "Disparene."

In 1904, Woodworth in giving directions for spraying for the codling moth, recommended either arsenite of lime or arsenate of lead as substitutes for Paris green in the fog belt areas of the state.[98] The next year, W. H. Volck, in work on the control of the codling

[96] Woodworth, C. W., and Colby, Geo. E., Calif. Agr. Expt. Sta., *Bul. 126*, p. 21 (1899).

[97] Colby, Geo. E., *Arsenical insecticides*, Calif. Agr. Expt. Sta., Bul. 151, pp. 28–29 (1903).

[98] Calif. Agr. Exp. Sta., *Bul. 155*, p. 5 (1904).

moth in the Pajaro Valley, recommended that Paris green be discarded in all sections where its careful use had resulted in injury to trees. That arsenate of lead which had been found reliable and non-injurious to vegetation be used and that the commercial product be used rather than the homemade product.[99]

In discussing the proposed insecticide law in 1906 Woodworth [100] calls attention to the fact that while in 1904–1905 there were but two commercial brands of arsenate of lead on the market, in 1905–1906 there were four brands available and that all of these brands "contained very little water-soluble arsenic compounds." From this time arsenate of lead became generally used for the control of leaf and fruit eating insects throughout the state. In 1912–1913 the powder form became available and has practically replaced the old paste form, which however is still on the markets at this writing (1927).

In 1916 George P. Gray and A. W. Christie of the insecticide laboratory, University of California, devised a boiling point method for the determination of water soluble arsenic in lead arsenate.[101] In the following year Gray [102] called attention to injuries caused to the foliage of stone fruits in the fog belt areas and urged the use of the basic arsenate of lead for such areas. The basic or neutral arsenate of lead was prepared by the California Spray Chemical Company to meet the foggy conditions often present in the Pajaro Valley and proved so satisfactory that it has become an important arsenical insecticide. It is now generally used in humid regions where the acid arsenate of lead causes injuries to fruit and foliage, and also in combination with such fungicides as lime-sulfur and Bordeaux mixture.

In 1918 A. L. Lovett estimated the annual production of arsenate of lead in this country to be 30,000,000 pounds.[103]

In 1926 a committee of entomologists of the California State Department of Agriculture, University of California and the Bureau of Entomology, U. S. Department of Agriculture, in making recommendations for the control of the codling moth in 1927, stated that "arsenate of lead is the only known insecticide that is practical and effective in codling moth control."

[99] Calif. Agr. Expt. Sta., *Circ. 14*, p. 10 (1905).
[100] Woodworth, C. W., Calif. Agr. Expt. Sta., *Bul. 182*, p. 183 (1906).
[101] *Jour. Industrial Engineering Chem.*, vol. 8, no. 12 p. 1109 (1916).
[102] *Jour. Econ. Entom.*, vol. 10, pp. 385–392, 1 fig. (1917).
[103] *Ibid.*, vol. 11, p. 57 (1918).

In the same year also Ralph H. Smith made a report [104] on the efficacy of this insecticide for the control of the codling moth which gives the very latest information relative to the use of arsenate of lead in this connection.

In connection with the control of the larvæ of the Japanese beetle (*Popillia japonica* Newm.) in Pennsylvania and Delaware, arsenate of lead was "mixed with the soil of a lawn or golf green at the rate of 1,500 pounds to the acre ($3\frac{1}{2}$ pounds per 100 square feet)," and killed the grubs.[105]

Calcium Arsenate

Calcium arsenate [106] is used as an insecticide in two forms, the calcium hydrogen arsenate, $CaHAsO_4$, and the more stable tri-calcium arsenate, $Ca_3\ (AsO_4)_2\ 2H_2O$. These materials are high in arsenical content and usually somewhat cheaper than arsenate of lead.

Through the courtesy of R. H. Smith, I received a copy of the statement published in the Atlanta Journal [107] stating the claims of W. C. Piver in connection with the discovery and first manufacture of calcium arsenate as an insecticide. In brief they are as follows: Mr. Piver, an industrial chemical engineer, began experimenting with insecticides in 1908 and became interested in calcium arsenates.

"The problem before me," he states, "was to find a compound of arsenic and lime which would be non-toxic to foliage, but deadly to leaf-eating and leaf-chewing insects that live on foliage. The problem was much more difficult than I anticipated. After a number of experiments I almost became con-

[104] *The efficacy of lead arsenate in controlling the codling moth*, Calif. Agr. Expt. Sta., Hilgardia, vol. 1, pp. 403–453, 19 figs. (1926).

[105] Leach, B. R., and Lipp, J. W., *Control of Japanese beetle grubs*, Pa. Dept. Agr., Bul., vol. 10, pp. 13–14 (Feb. 15, 1927).

[106] Scott, W. M., *Arsenate of lime or calcium arsenate*, Jour. Econ. Entom., vol. 8, pp. 194–197 (1915).

Sanders, G. E., *Arsenate of lead vs. arsenate of lime*, Proc. Entom. Soc., Nova Scotia, p. 40 (1916).

Lovett, A. L., and Robinson, R. H., *Toxic values and killing efficiency of the arsenates*, Jour. Agr. Research, vol. 10, pp. 199–207 (1917).

Robinson, R. H., *The calcium arsenates*, Ore. Agr. Exp. Sta., Bul. 131, 15 pp. (1918).

Lovett, A. L., *The calcium arsenates*, Jour. Econ. Entom., vol. 11, pp. 57–69 (1918).

Piver, W. C., *The Atlanta Journal* (July 25, 1926).

Wardle, R. A., *Problems of applied entomology* (New York, McGraw-Hill, 1929), pp. 165–166.

[107] Piver, W. C., *op. cit.*

vinced that such a compound could not be made. . . . And finally I found the compound.

"The first batch of calcium arsenate for commercial uses was manufactured in April, 1912 and sent to Houston, Texas, to be used to destroy the cotton leaf worm."

Tests of sprays of this new insecticide were made by W. M. Scott on apple trees in Virginia in 1913, and other experiments in connection with insects attacking various plants followed.

This compound has caused considerable burning to foliage, but modifications in manufacture and continued experimentation of

FIG. 135.—Spray injury to fruit has not yet been entirely overcome by the use of modern insecticides and fungicides as is shown by the Bordeaux mixture injury to the pear on the left and the lime-sulfur injury to the one on the right. (Photograph taken at Monticello, California, September, 1928, by Stewart Lockwood.)

its uses may create a place for it among the present commonly used arsenical insecticides.

ARSENITE OF ZINC

Arsenite of zinc, a white powder of high arsenic content and a considerable amount of water-soluble arsenic, has been often used in California as a substitute for Paris green and arsenate of lead, but has proven unsatisfactory for general orchard work.

In 1911 it was advocated for the control of the California tussock

moth, cankerworms, and the codling moth in the dry interior valleys.

Tobacco

Tobacco in the form of a finely ground dust or as a decoction was one of the earliest insecticides used for the control of aphis, thrips and other small insects. According to Lodeman,[108] "In the year 1763, there appeared in the papers of Marseilles a remedy for plant lice. The applications should be made by means of a small tin syringe having a nose pierced by about one thousand holes. The instrument is filled with water in which lime has been slaked, previously mixing with the clear liquid some bad tobacco, finely powdered; this should be used at the rate of a handful to two liters of the liquid. The trees are syringed with the mixture, and although the foliage remains uninjured the pests are destroyed. But after four or five days the trees should be again syringed, using clear water.

"But many of the plant-lice may be destroyed by passing the leaves upon which they are found between two sponges wet with tobacco water. Ground tobacco powder spread upon the insects will kill them instantly. One may also use with it the water of slaked lime or of strong soap, soot, sage, hyssop, wormwood, and other bitter or strong-smelling herbs." [109]

In America Thacher [110] gives a formula for the control of caterpillars used by Yates, Albany, N. Y., in 1822, which included tobacco as follows:

Wormwood	1 handful
Rue	1 "
Virginia tobacco	2 handfuls
Water	2 pailfuls

The ingredients were boiled together one-half hour and the clear liquid strained off and used. "Yates also said that if sufficient tobacco is used alone, it will answer the same purpose as the above, but not so well." However, "a decoction of tobacco was pronounced to be excellent for the removal of aphis, thrips, and wood lice."

[108] Lodeman, E. G., *The spraying of plants* (New York, Macmillan, 1897), pp. 5, 8, 10.

[109] Lodeman quoted from J. A. E. Gœze, *Geschichte einiger schädlichen insecten* (Leipzig, 1787), pp. 164, 166.

[110] Thacher, J., *American Orchardist*, p. 96 (1822).

Thomas Fessenden [111] recommended tobacco water for insects again in 1832.

For many years tobacco was one of the most important insecticides.

T. W. Harris recommended fumigating with tobacco for the vine hopper as early as 1841,[112] and also a mixture of soapsuds and tobacco-water and tobacco-tea, for the destruction of aphis.[113] It has been extensively used ever since.

W. B. West, member of the Board of State Horticultural Commissioners of California [114] recommended a mixture of whale-oil soap, sulfur, and tobacco as a summer spray for the control of red spider on deciduous fruit trees in 1882.

In the same year Ellwood Cooper,[115] President of the Board, announced success in controlling black scale on olive trees with forty pounds of leaf tobacco boiled in eighty gallons of water.

The next year Matthew Cooke suggested Ellwood Cooper's remedy for black scale, which was modified to thirty pounds of tobacco leaves boiled in thirty gallons of water and applied at a temperature of 130° F. He further stated that "every fruit-grower should grow a small patch of tobacco upon his premises. Ellwood Cooper, of Santa Barbara, grows all the tobacco he required for insecticides, at a cost of about two cents per pound." [116]

Tobacco-soap, made by boiling together one-half pound of tobacco, one-half pound of soap and one gallon of water, applied hot, was recommended for the woolly aphis by W. G. Klee in 1886.[117]

Commercially prepared nicotine decoctions soon began to appear on the markets, at first containing only about 2% nicotine. In 1912 the 40% nicotine sulfate became the standard proprietary tobacco insecticide in California and continues to date. It is used alone or in combinations of soap, oils, and dusts, for aphis, leafhoppers, thrips, white flies, and other small insects. Used alone it is usually diluted, one part to from 1,000 to 1,500 parts of water. In combination with soap or oil sprays usually one pint is added to two hundred gallons of spray.

111 *New American Gardener*, ed. 6, p. 169 (1832).

112 *Rept. on the insects of Massachusetts injurious to vegetation* (Cambridge, Mass., Folsom, Wells, and Thurston, 1841), pp. 185, 196.

113 *Ibid.*, pp. 195–196.

114 *First Rept.*, pp. 20–21 (1882).

115 *Ibid.*, p. 39 (1882).

116 *Injurious insects of the orchard, vineyard, etc.*, p. 372 (1883).

117 Calif. Agr. Expt. Sta., *Bul. 56* (1886).

The effects of nicotine as an insecticide were investigated by N. E. McIndoo in 1916.[118]

Nicotine dust made by treating finely ground kaolin or lime with the 40% nicotine sulfate was invented by Ralph E. Smith,[119] University of California in 1917, who conducted the first experiments for the control of the walnut aphis, *Chromaphis juglandicola* (Kalt.) at Goleta, Santa Barbara County, in May and June. Further tests were made during the summer of 1918. In 1919 a mixing plant was set up at Goleta, capable of mixing four hundred pounds at a time. Forty tons of dust were made and used that year with excellent success in the control of the walnut aphis. In 1920 the California Walnut Growers' Association erected an improved mixing plant at Los Angeles and have continued to manufacture the dust to date. Other spray companies also make nicotine dusts in many parts of the country. Various carriers such as lime, kaolin, and gypsum are used and the nicotine dust is often combined with sulfur or dry arsenicals as general insecticides.

During the spring of 1920 I carried on experiments with nicotine dust for the control of the pear thrips, *Tæniothrips inconsequens* Uzel,[120] in the Santa Clara Valley and obtained excellent results, which were repeated during the succeeding four years.

The popularity of this new method of applying nicotine is evidenced by the number of experiments and bulletins [121] which

[118] *Jour. Agr. Research*, vol. 7, pp. 89–122, pls. 1–3 (1916).

[119] *The preparation of nicotine dust as an insecticide*, Calif. Agr. Exp. Sta., Bul. 336, pp. 261–274 (1921).

[120] Essig, E. O., *The pear thrips*, Calif. Agr. Expt. Sta., Circ. 223, pp. 7–9 (1920).

[121] Campbell, R. E., *Nicotine sulphate in a dust carrier against truck-crop insects*, U. S. Dept. Agr., Dept. Circ. 154, 15 pp., 5 figs. (Feb. 21, 1921).

Nicotine dust for control of truck crop insects, *ibid.*, Farmers' Bul. 1282, 12 pp. (1922).

White, W. H., *Nicotine dust for control of the striped cucumber beetle* (*Preliminary report*), *ibid.*, Dept. Circ. 224, 8 pp., 3 figs. (June, 1922).

Headlee, T. J., and Rudolfs, W., *Some principles which underlie the making and use of nicotine dust*, N. J. Agr. Expt. Sta., Bul. 381, 47 pp., 18 figs. (January, 1923).

Thatcher, R. W., and Streeter, L. R., *Factors which affect the volatility of nicotine from insecticide dusts*, N. Y. Agr. Expt. Sta., Bul. 501, 34 pp. (March, 1923).

MacLeod, G. F., and Harman, S. W., *The aphiscidal properties of tobacco dust*, *ibid.*, Bul. 502, 18 pp., 3 pls. (April, 1923).

Dudley, J. E., *Nicotine dust kills cucumber beetles*, Wisc. Agr. Expt. Sta., Bul. 355, 10 pp., 4 figs. (June, 1923).

De Ong, E. R., *The relation between the volatility and toxicity of nicotine in sprays and dusts*, Jour. Econ. Entom., vol. 16, pp. 486–493 (1923).

Cory, E. N., and Potts, S. F., *The control of truck crop pests by dusting*, Md. Agr. Expt. Sta., Bul. 261, pp. 121–155, 17 figs. (February, 1924).

Hackett, H. C., *The control of aphids which infest cauliflower seedbeds on Long Island by means of tobacco dust mixtures*, Jour. Econ. Entom., vol. 18, pp. 128–132 (1925).

followed almost immediately and which proved beyond doubt the value of the discovery to all parts of the country.

In 1925 [122] a specially constructed machine, which mixed the dust in the field as it was being applied, was placed upon the market and now insures a perfectly fresh and reliable product.

Nicotine dusts are now in competition with cyanide dusts which became available in 1922; however, they are still used for walnut aphis, thrips, and garden insects because they are considerably cheaper and less offensive to apply.

Pyrethrum[123]

The use of pyrethrum as an insecticide was early held as a secret in Transcaucasia where the plants, locally known as Persian camomile, flea-grass, or flea killer, grew wild in the Caucasus Mountains at an elevation of 5,650 feet and at a temperature of 68° F. An Armenian merchant, Jumtikoff, who traveled through this region about 1807 or 1817, noted the value of the prepared powder and transmitted the information to his son who prepared the insecticide in sufficient quantities for export in 1828. The plant was soon afterwards introduced from the Russian Caucasus into

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Further studies concerning the aphiscidal properties of tobacco dust, N. Y. Agr. Exp. Sta., Tech. Bul. 121, 29 pp., 4 charts (August, 1926).

[122] Smith, R. E., and Martin, J. P., *A self-mixing dusting machine for applying dry insecticides and fungicides*, Calif. Agr. Expt. Sta., Bul. 357, pp. 497–505, 3 figs. (April, 1923).

[123] *Persian insect powder*, U. S. Patent Office Rept., 1857, Agr., pp. 129–130 (1858).

On the destruction of noxious insects by means of the Pyrethrum willemoti *Duchartre* (translated from the French by C. Willemot), *ibid.*, Rept., 1861, pp. 223-231 (1862).

The pyrethrums as insect-destroyers, U. S. Commr. of Agr., Rept., 1877, pp. 59–60 (1878).

Persian insect powder and Buhach, Calif. College of Agr., Rept. Suppl., pp. 68–71 (1879).

Pyrethrum: its use as an insecticide, Rept. U. S. Com. Agr., 1881–1882, pp. 76–87 (1882).

Klee, W. G., *The insect powder plant*, Calif. College of Agr., Rept., 1882, pp. 112-114 (1883).

Riley, C. V., *Vegetable insecticides*, U. S. Entom. Comm., Rept. 4, pp. 164–180, pls. xii–xiii (1885).

Coquillett, D. W., *Report on the production and manufacture of Buhach*, U. S. Dept. of Agr., Div. Entom., Bul. 12, pp. 7–16 (1886).

Lawrence, E. S., *On a Buhach plantation*, Californian Illustrated Mag., vol. 2, no. 3, pp. i–xiii, figs. (1892).

Lodeman, E. G., *The spraying of plants* (New York, Macmillan, 1897), pp. 52, 78, 116, 165–166.

Bailey, L. H., *Standard Cyclop. Hort.*, vol. 2, pp. 753, 757 (1914).

Abbott, W. S., *A study of the effect of storage, heat and moisture on pyrethrum*, U. S. Dept. Agr., Bul. 771 (prof. paper), 6 pp. (1919).

Le Pyrèthre de Dalmatie, Rev. Agr. Africa Nord, Algiers, no. 63, pp. 306–307, 1 fig. (Oct. 15, 1920). Methods of production of pyrethrum in Algiers.

Alexandropal and subsequently into Germany, where its value was quickly recognized. A powder was made from the dry flower heads

FIG. 136.—Advertisement for Buhach, a pyrethrum powder, in 1881. Some forms of this insufflator, for applying the powder, are still on the markets. In the earlier days Buhach was very extensively used, not only for aphis and leafhoppers, but more particularly for fleas and bedbugs. (Pacific Rural Press, San Francisco, 1881.)

and an infusion from the dry leaves. A volatile oil is the active principle as an insecticide.

According to Juettner and Siedler,[124] the active agent, Et_2O ($C_4H_{10}O$), has been obtained in the following proportions in the pyrethrum plants:

Extracted from	
The powdered stems	1.48%
The flowers	6.14%
Extracted with petroleum ether extractives:	
From the stems	1.01%
From the flowers	4.01%

The Caucasian plant was generally known as *Pyrethrum roseum* and is now referred to as *Chrysanthemum coccineum* Willd. The

[124] Juettner, E., and Siedler, P., *Berlin Pharm. Ges.*, vol. 22, pp. 397–417 (1913).

material made from this plant was commercially called Persian insect powder. In Dalmatia, Jugoslavia, a similar insect powder was produced and as carefully guarded as a secret. It was known in the trade as Dalmatian insect powder and was produced from a plant, *Pyrethrum cinerariæfolium* (Vis.), claimed to be a native of that region. It was many years before seeds could be procured to grow either of these plants elsewhere.

The powder from the Caucasus of Persia and also from Dalmatia was introduced into France to destroy household insects about

FIG. 137.—The Buhach Farm of the Buhach Producing and Manufacturing Company near Atwater, Merced County, California. Here as many as two thousand acres at one time were devoted to the cultivation of the Dalmatian pyrethrum. D. W. Coquillett experimented with poison baits for controlling grasshoppers here on July 12, 1885. (After E. S. Lawrence, 1892.)

1850. Some raw material was secured a few years later and it was definitely determined that the powder from the Caucasus was the best. Accordingly in 1856 seeds were procured from the latter place and sown on September 15, 1856, and the few plants raised produced enough seed to establish the industry in France in 1857. The species thus evolved was determined a new species, as *Pyrethrum willemoti* Duchartre, but was nothing more than the one referred to above as the Caucasian plant. The industry in France was carefully guarded to prevent the dissemination of seeds to other countries.

G. N. Milco, a native of Dalmatia, a resident of Stockton, California, and afterwards a member of the State Board of Horticulture of California, secured a few seeds from Gravosa in 1876, which he tried out and found successful. The species grown by him was considered to be *Pyrethrum cinerariæfolium* Vis. (now *Chrysanthemum*) by most of the writers of that time, but Bailey gives the species as *Chrysanthemum coccineum* Willd. In an advertisement in

FIG. 138.—Pyrethrum in full flower and ready for cutting. In harvesting this crop the flower stalks were cut and the heads stripped off by pulling the stems through a coarse comb. J. D. Peters, one of the owners of the Buhach Farm, is the man with the derby hat. (After E. S. Lawrence, 1892.)

1878, Milco states the plant is true *Pyrethrum carneum.*[125] Soon after its introduction, Milco organized the Buhach Producing and Manufacturing Company at Stockton. Associated with him were J. D. Peters and A. C. Paulsell. The company procured 800 acres in the San Joaquin Valley, near Atwater, Merced County (Fig. 137). A building was erected at Stockton and the insect powder prepared for use was known by the trade name "Buhach." Milco sent samples of his powder to many of the leading entomologists for trial. Among those who experimented with it were C. V. Riley, who used it quite extensively in his experiments on the control of the cotton worm, *Alabama argillacea* (Hbn.) which he published in the report already referred to. B. D. Walsh, Cyrus Thomas, A. J. Cook, J. H. Comstock, E. A. Schwarz and others also gave it trial. Paulsell soon retired from the company and Milco died in 1886, but Peters continued operations with vigor. By 1888 he had 300

[125] *Pacific Rural Press*, vol. 16, p. 158 (Sept. 7, 1878).

acres under cultivation and employed from 100 to 200 men during the busy season. In one year 2,000 acres were under cultivation. The seeds of pyrethrum were sown in the spring or fall in seed-beds and were transplanted during the late winter or spring in rows four feet apart and two feet apart in the rows. One, two, or three ir-

FIG. 139.—Harvesting scene on the Buhach Farm, near Atwater, California, in 1890. The men are cutting the stalks and stripping the flower heads of pyrethrum. (Photograph furnished by the Buhach Producing and Manufacturing Company.)

rigations followed, the water being applied by a furrow between each row. Thorough cultivation succeeded irrigation and the crop was ready for harvest in May or June (Figs. 138, 139). "The harvesting time is generally the end of May, when the stalks are cut off at the roots of the plant with a sickle; the flowers are then stripped off by passing the stems through a coarse kind of comb which detaches them and allows them to drop into a box in front of the gatherer. As each box is filled, its contents are carried to the drying ground (Fig. 140) where the flowers are spread upon sheets and exposed to the rays of the sun, being frequently turned over. At night they are carefully covered to prevent them from absorbing moisture. This is an indispensable precaution, because the more

quickly and thoroughly the drying process is performed the better the quality of the *Buhach* obtained from the flowers. The volatile oil which gives the powder its insecticide properties is then retained as fully as possible whereas, if the least dew is allowed to fall upon the flowers while drying they become discolored and their properties weakened. When the flowers have been thoroughly dried they are shipped to the mill at Stockton where they are reduced to pow-

FIG. 140.—Drying pyrethrum flower heads in trays and a load of the dried and sacked product ready for shipment to the mill at Stockton, where the powder known as Buhach, was and still is manufactured. (After E. S. Lawrence, 1892.)

der." [126] Only the full-blown flowers were gathered. These were dried and put through a set of burr millstones, not unlike those used for grinding wheat in those days. The resultant grist was sifted and the finest powder put into tight tin cans to be sold as Buhach. The coarser material was then returned to the mills for regrinding. The first powder was sold by Milco in 1873 for sixteen dollars per pound, but finally dropped to a wholesale price of from forty-five to sixty cents per pound, and retailed at from seventy-five cents to one dollar and twenty-five cents per pound. The powder was applied in small quantities by means of an insufflator or what was commonly known as a flea powder box, as shown in Fig. 136.

[126] Lawrence, E. S., *op. cit.*, pp. vi, viii.

In large quantites it was applied by means of a bellows attached to a tin container not unlike a modern atomizer.

E. W. Hilgard of the California Experiment Station was quite interested in the product and made one of the first decoctions, which proved effective against certain insects. Buhach, although still sold as an aphiscide and general insecticide, is most effectively

FIG. 141.—An experimental plot of pyrethrum grown at Natividad, Monterey County, California, in 1927. The plants were cut with a mower and the entire plant, including the stalks and flowers, were used in obtaining the active principle for use as an insecticide. (Photograph furnished by J. S. Yip.)

used in dusting beds for fleas and bedbugs and is one of the best remedies for these insects.

Matthew Cooke [127] prescribed Buhach for many insect troubles such as for mosquitoes, house flies, aphis, grape leafhopper, clothes moths, dried fruit moths, and caterpillars.

Buhach is still manufactured by the descendants of Peters under the same corporation name, but instead of growing the

[127] *Injurious insects of the orchard, vineyard, etc.*, pp. 375, 403–421 (1883).

plants in California the flower heads are imported from Japan, where they can be produced cheaper than here.

In 1921 and 1922, W. P. Duruz made some tests with Buhach in the control of cankerworms on cherry trees at Vacaville. He used five pounds to two hundred gallons of water. The Buhach was allowed to soak in cold water overnight. No record was officially made at that time of the excellent results he obtained. In 1927 an outbreak of cankerworms in a cherry orchard at Yuba City occurred and Duruz, who happened to be then working there on the control of peach rust, suggested Buhach as he had used it at Vacaville. It gave most excellent results and the success was given sufficient publicity to cause the material to be used for cankerworms in many parts of the state. In every case surprisingly good results were obtained.

> Pyrethrum as an insecticide for spraying on plants and trees has come to the fore during the past two seasons, and those orchardists who have followed these columns have noted frequent reports of highly successful use against such pests as the cankerworm. It is also effective against aphis and other sucking and chewing insects.
>
> This popularity is reflected in the sharp increase in U. S. imports of pyrethrum flowers from Jugoslavia, reported by the U. S. Department of Commerce through S. C. McMillan at Belgrade. Another important source of material is Japan.
>
> In 1926 imports from Jugoslavia were 77,693 pounds. In 1927 they rose to 623,970 pounds, valued at $99,306, at the rate of 16 cents per pound. In 1928 our imports again jumped to 1,024,083 pounds, valued at $237,648, at the rate of about 23 cents per pound.
>
> Annual production of pyrethrum flowers in Jugoslavia amounts to about 1,400 metric tons, and a third of the 1928 crop came to this country. It is produced principally in Dalmatia and Montenegro in the Zagreb district, and last year 96 per cent of the shipments were invoiced from Belgrade.[128]

The increased importations of pyrethrum into this country are due to the manufacture and extensive sale of various "fly sprays" in which it is an important ingredient.

Hellebore

The term hellebore is applied to medicinal and insecticidal products. The medicinal or black hellebore is obtained from the so-called Christmas rose, *Helleborus niger* Linn., of Europe and is used as a cathartic and is a violent poison if taken in an overdose. The insecticidal product is a pale yellowish-brown powder obtained from both the European white hellebore, *Veratrum album*

[128] *Pacific Rural Press*, vol. 117, p. 361 (March 16, 1929).

Linn., and the American white hellebore, or Indian poke, *V. viride* Ait. In California four species of this genus of plants grow wild, the corn lily or false hellebore, *Veratrum californicum* Durant, in the meadows of the Sierra Nevada Mountains at 4,500 to 8,500 feet, and in high altitudes of Coast Range Mountains and the mountains of Washington to southern California, to Colorado and to Mexico; the American white hellebore, *V. viride* Ait., in the subalpine meadows of northern California to Alaska and east to the Atlantic Coast; *V. fimbriatum* Gray, along the coast of Mendocino County; and *V. insolitum* Jepson, on the red clay hills in the chaparral of Del Norte County and in southern Oregon.[129] So far as is known none of these plants have been utilized for insecticidal purposes in California. White hellebore [130] was used as an insecticide in Europe as early as 1787 [131] for the destruction of aphis in France. It was commonly recommended in England in 1842 to destroy worms on gooseberry plants.

In America it was first used by Joseph Harris about 1861 to control the imported currant worm, *Pteronidea ribesi* Scopoli, which was discovered in 1857.

In 1896 Lodeman referred to it as follows: "If properly applied, it is very effective in destroying chewing insects, and more than two applications are rarely necessary. Only the fresh powder should be used. It may be applied either in dry form or when mixed with water. When used in the form of a dry powder, it is generally applied pure, but may be successfully diluted with once or twice its bulk of plaster, lime, or flour, the last causing it to adhere more firmly to the foliage. In cases where the insect does not yield readily to treatment, applications of the pure powder may be advisable. The powder should be sifted uniformly upon the foliage.

"When used in water the following formula may be successfully employed:

Hellebore (fresh)	1 ounce
Water	3 gallons

"Some recommend the addition of an ounce of glue to the above mixture, or a small amount of flour, in order to render it more adhesive; yet for general practice such additions are scarcely necessary."

Although the powder has been on the market in drug stores for many years and is still to be obtained there, it has never been used to any extent as an insecticide in this state. C. W. Wood-

129 Jepson, W. L., *A manual of the flowering plants of California* (Berkeley, 1925), p. 213.

130 Lodeman, E. G., *The spraying of plants* (New York, Macmillan, 1897), pp. 5, 13, 18, 148.

131 Gœze, J. A. E., *Geschichte einiger schädlichen Insecten* (Leipzig, 1787), p. 164.

worth states that he has run across it many times in connection with the enforcement of the State Insecticide Law, but that he has never noted it used for the control of insects, except perhaps by an occasional housewife upon recommendation of a druggist.

In the eastern states it has been used for the control of the currant worm on plants in fruit, for the reason that there was no fear from poisoning on account of small quantities of it. It is applied as a spray or as a dust in the pure state or mixed at the rate of one to three of hydrated lime.

QUASSIA [132]

Quassiin or quassia extract, obtained chiefly from the Jamaica quassia wood, *Picrasma excelsa* Planch., or from Surinam quassia, *Quassia amara* Linn., has been used in Europe as an insecticide for many years, but apparently the first authentic record is that made by Ormerod [133] in 1885 in connection with the control of the hop aphis, *Phorodon humuli* (Schrank). The spray was prepared by using six pounds of quassia chips, three pounds of soft soap, and one hundred gallons of water.

It appears to have been first experimented with in America by W. B. Alwood [134] on the same insect in 1888. He used one pound of chips to two gallons of water, but did not consider it a practical remedy. These experiments probably led Riley and Howard to discourage its use for the hop aphis in Oregon and Washington in 1891.[135] However, Kœbele [136] and Washburn [137] experimenting with a solution of six pounds of quassia chips, three pounds of soap, and one hundred gallons of water, on the hop aphis in Oregon and Washington in 1893, secured satisfactory results and recommended this solution for that particular insect. In California, Clarke [138]

[132] Parker, W. B., *Quassiin as a contact insecticide*, U. S. Dept. Agr., Bul. 165 (Prof. paper), 8 pp., 1 fig. (1914).

McIndoo, N. E., and Sievers, A. F., *Quassia extract as a contact insecticide*, Jour. Agr. Research, vol. 10, pp. 497–531, figs. 1–3 (1917).

[133] Ormerod, Elanor A., *Hop aphis, and damson-hop aphis*, Aphis (Phorodon) humuli, *Schrank; and* Aphis (Phorodon) humuli; *var.* mahaleb, *Fonsc.; Rept. observations injurious insects*, vol. 8, pp. 43–56 (1885). The wash used extensively in England in 1882 was made of one hundred gallons of water, four to five pounds of pure soft soap, six to eight pounds of quassia, boiled well to get the full extract. *Manual of injurious insects and methods of prevention* (ed. 2, 1890), p. 124.

[134] U. S. Commr. Agr., *Rept. for 1888*, pp. 102–111 (1889).

[135] Riley, C. V., and Howard, L. O., *Insect Life*, vol. 4, pp. 84, 346 (1891).

[136] Kœbele, A., *Insect Life*, vol. 6, pp. 12–17 (1893).

[137] Washburn, F. L., Ore. Agr. Expt. Sta., *Bul. 25*, p. 10 (1893).

[138] Clarke, W. T., *The hop aphis*, Calif. Agr. Exp. Sta., Bul. 160, 13 pp., 7 figs. (1904).

experimented on the control of the hop aphis in 1903 with kerosene emulsion and tobacco and also with an extract of quassia made by first soaking for several days and then boiling for two hours, seven pounds of quassia chips in three gallons of water, adding nine pounds of whale oil soap previously dissolved in water, and sufficient water to make two hundred and fifty gallons of spraying material. This was used in from one to three applications of six gallons per acre. Both of these insecticides proved effective.

In 1913, Parker [139] conducted a series of experiments with various quassia extract mixtures and ascertained that mixtures consisting of quassia extract and soap solutions were effective in killing the hop aphis in the fields and concluded that the soap formulas containing quassiin were almost as effective as those containing nicotine sulfate.

McIndoo and Sievers [140] in 1917 published a comprehensive report on quassia extract as a contact insecticide and gave a historical account of the material as a medicine, as an insecticide, methods of its preparation, effectiveness as an insecticide, effective formulas, solvents, pharmacological effects, and complete bibliography. In the summary the following facts are important to this discussion:

> In conclusion, it should be stated that owing to the poor insecticidal properties of quassiin, quassia extract can never become a general insecticide for all aphids. Of course, the amount of extract to be used could be sufficiently increased so that the spray solution would perhaps be efficient on any particular aphid, but in most cases the expense would prohibit its use. The most effective formula used by the writers was prepared by soaking 22 pounds of quassia chips in 100 gallons of fish-oil soap solution (1.6 pounds of soap to 100 gallons of water) for 24 hours. This spray solution under the most favorable conditions was efficient on only two of the six species of aphids tested, but the results as recorded are comparable to those obtained by using nicotine sulfate solution. Nevertheless, owing to the slow action of quassiin, this spray solution is much less reliable than is nicotine sulfate solution, because the aphids sprayed have better opportunities to migrate, and should it rain a few hours after the solution has been applied its effectiveness would be greatly reduced, while such is not true for nicotine sulfate solution. This spray solution, not including the cost of preparing it, is almost as expensive as nicotine sulfate solution (1:800 of soap solution).

[139] Parker, W. B., *op. cit.*
[140] McIndoo, N. E., and Sievers, A. F., *op. cit.*

Sulfur

Sulfur was early used as an insecticide. When burned the fumes were found to be effective in the control of aphis [141] and other cereal infesting insects, clothes moths, carpet beetles, and other insects which were confined in rooms or buildings.

Matthew Cooke recommended ten pounds of fine sulfur and one pound of Buhach, thoroughly mixed, for the control of the grape leafhopper in 1883.[142] The sulfur also prevented grape mildew.

Flowers of sulfur was used for dusting fruit trees for the control of the red spider in California prior to 1895 [143] and was also suggested for the control of thrips. It was applied by the pepper box method or the bag-sifting method. At that time sulfur was widely used for the control of grape mildew. The use of various kinds of dry sulfur in the form of flowers of sulfur and ground sulfur continue to be used for the above mentioned purpose. Sulfur was applied alone or often mixed with half as much or an equal quantity of powdered hydrated or slaked lime.

Dusting with sulfur for the control of orchard mites reached its height in 1909–1914 after which the use of various types of wettable sulfurs in the form of sprays became popular. Atomic sulfur, a proprietary mixture composed of sulfur, glue, and water came in about this time. Sulfur was made wettable also by the use of flour,[144] diatomaceous earth, and later on, by the use of calcium caseinate in 1922–1923. The appearance of very finely ground sulfur in 1925 and the so-called gas-house sulfur [145] in 1926 have revived dusting somewhat, but the wet sprays give more satisfactory results than the dusts in certain places although both types are now generally used. De Ong [146] conducted some extensive experiments with sulfur for the control of red spiders in deciduous orchards in 1920–1922 and gave a good idea of the use of sulfur at that time and just before the summer oil sprays appeared.

Highly refined summer oil sprays appeared in 1924–1925 and

[141] T. W. Harris recommended fumigating greenhouses with sulfur to kill plant lice, *Rept. on the insects of Massachusetts injurious to vegetation*, p. 196 (1841).

[142] *Insects injurious to orchard, vineyard, etc.*, p. 375 (1883).

[143] Woodworth, C. W., Calif. Agr. Expt. Sta., *Rept. for years 1895–1896, 1896–1897*, pp. 213–233 (1898).

[144] Flour paste was used at the rate of four pounds of flour to one hundred gallons of water and fifteen pounds of ground or sublimed sulfur in 1903.

[145] A refined by-product in the manufacture of gas used for city and domestic purposes.

[146] De Ong, E. R., *The control of red spiders in deciduous orchards*, Calif. Agr. Expt. Sta., Bul. 347, pp. 39–83, 12 figs. (1922).

have to a considerable degree replaced sulfur for the control of mites except for certain shipping fruits and grapes which are marketed in the freshly ripened condition and the appearance of which is greatly marred by the removal of the bloom, due to the application of oil sprays prior to picking.

New finely divided sulfur dusts appeared in 1929 and proved to be effective, not only for the control of orchard mites, but also for bean thrips on pears and citrus thrips as well as for the citricola scale in Tulare County.

LIME-SULFUR

The history of the discovery of this valuable fungicide and insecticide is not easily traceable. Lodeman [147] has furnished the following facts:

William Kenrick [148] in 1833 gave two formulæ for the preparation of such a mixture.

The first was for insects and was prepared by mixing in boiling water:

Quicklime	$\frac{1}{2}$ peck
Flowers of sulfur	$\frac{1}{2}$ pound
Lampblack	$\frac{1}{4}$

The second for mildew on grapes was:

Sulfur	$\frac{1}{2}$ pint
Quicklime	piece size of fist
Water (boiling)	2 gallons

When the mixture cooled it was diluted with water, allowed to settle, and the clear liquid drawn off for use.

The first known real lime-sulfur solution was prepared by Grison,[149] head gardner at Versailles, France, in 1851. It was known as *Eau Grison* or Grison liquid and was prepared as follows:

Flowers of sulfur	500 grams
Freshly slaked lime	500 "
Water	3 liters

The ingredients were boiled for 10 minutes, allowed to settle, after which the clear liquid was drawn off and kept in bottles. For use it was diluted 1 part to 100 parts of water. It was used only as a fungicide for surface mildews.

[147] Lodeman, E. G., *The spraying of plants* (New York, Macmillan, 1897), pp. 12, 16, 147, 157–158.

[148] *The new American orchardist*, pp. xxxvi, 328 (1833).

[149] Heuzé, G., *Maladie de la vigne*, Revue Horticole (4) vol. 1, pp. 168–170 (1852).

The lime-sulfur-salt wash [150] was first prepared as a sheep dip in Australia and used for the same purpose in California by A. T. Covell in 1885–1886: he did not then realize its value as a tree spray. This discovery was made by F. Dusey of Fresno, who experimented with the material obtained from Covell as a spray for fruit trees in 1886.

In the Report for the years 1885 and 1886 [151] Ellwood Cooper recommended for flowering shrubs or garden plants the following formula:

Sulfur	2 pounds
Lime	1 pound
Water	2 gallons

Boil one hour; dilute the mixture with three or more gallons of water.

It is not stated where he got the idea, but it must have originated with the work of Covell and Dusey, inasmuch as Cooper, as president of the State Board of Horticulture, was in close touch with all such insect pest control work throughout the state.

The new material was very successful in killing the San José scale on dormant deciduous fruit trees and at once became popular. B. M. Lelong, secretary of the State Board of Horticulture of California, in the Third Biennial Report for the thirty-eighth and thirty-ninth fiscal years, published in 1888, lists two formulas for preparing this spray,[152] showing that there was keen competition and a difference of opinion as to the proper one to use. They were:

Salt and Lime Remedy

Recommended by Mr. I. H. Thomas.

Twenty-five pounds of lime (unslaked); twenty pounds of sulfur; fifteen pounds of salt; sixty gallons of water.

To mix the above, take ten pounds of lime, twenty pounds of sulfur, and twenty gallons of water. Boil until the sulfur is thoroughly dissolved. Take the remainder—fifteen pounds of lime and fifteen pounds of salt—slake, and add enough of water to make the whole sixty gallons. Strain and spray on the trees milk-warm or warmer. This can be applied when the foliage is off the tree, and will have no injurious effect whatsoever on the fruit buds or tree.

[150] Lodeman, E. G., *op. cit.*, pp. 157–158.
Quayle, H. J., Calif. Agr. Exp. Sta., *Bul. 166*, pp. 5–14 (1905).
[151] State Bd. Hort. of Calif., *Bien. Rept., 1885 and 1886*, p. 36 (1887).
[152] Page 277.

Recommended by Mr. A. T. Covell.

Fifty pounds of unslaked lime; twenty pounds of French sulfur; fifteen pounds of salt.

Prepared as follows: Place ten pounds of lime and twenty pounds of sulfur in a heater with twenty gallons of soft water. Boil for half an hour or more, until both lime and sulfur are dissolved. The sulfur must be thoroughly dissolved and mixed with the lime; the mixture will then be of an amber color. Next place in a cask or box forty pounds of good lime and pour upon it enough soft hot water to thoroughly slaken the lime and keep it in a liquid form. After the lime is thoroughly slaked, add fifteen pounds of common stock salt while the material is hot. When the salt is well dissolved mix the two lots together, with sufficient water to make sixty gallons of spraying material, which will then be a thin whitewash. The material should be strained after being thoroughly mixed—a good piece of burlap answering well for the purpose. Apply the mixture with a spray pump, using rubber plate in the nozzle instead of the brass plate.

This spray became generally known as the California wash. All of the early formulas contained various amounts of salt as shown in the following table.[153]

	Lime Lbs.	Sulfur Lbs.	Salt Lbs.	Sugar Lbs.	Water Gals.
1886, Original formula (sheep dip)	80	100	10	20	160
1887, I. H. Thomas	25	20	15	..	60
1887, A. T. Covell	50	20	15	..	60
1890, I. H. Thomas	30	25	15	..	60
1891, Lelong's report	40	20	15	..	60
Hort. Com. Sutter County	40	20	15	..	60
1904, Recommended by H. J. Quayle	30	15	10	..	60
1906	80	60	..	..	200
1911	33	66	..	..	200
1918–27 (Diluted for use)	50	100	..	..	50
	80	160	..	..	50

With the discovery of the San José scale in Virginia in 1893 and in other eastern states shortly afterward, the lime-sulfur-salt wash was experimented with by C. L. Marlatt and D. W. Coquillett in Maryland in 1894. They reported it as practically valueless "even at twice the strength reported to be effective on the Pacific Slope." [154] However, later experiments proved that the California wash was as effective in the East as in the West and it soon was placed at the head of all sprays for the San José scale throughout

[153] Quayle, H. J., *op. cit.*, p. 6 (1905).

[154] Howard, L. O., and Marlatt, C. L., U. S. Dept. Agr., Div. Entom., *Bul. 3* n. s., pp. 56–58, 61 (1896).

the entire country. The formulas recommended by the various states up to 1904 are shown in the following table.[155]

	Lime Lbs.	Sulfur Lbs.	Salt Lbs.	Water Gals.	Time Cooked
U. S. Dept., Washington	40	20	15	60	2 hrs.
New Jersey	50	50	50	150	1½ hrs.
Maryland	40	20	15	60	2 hrs.
Georgia	30	20	15	60	2½–3 hrs.
Illinois	15	15	15	50	1¼ hrs.
New York (Geneva)	40	20	15	60	2–2½ hrs.
Kentucky	20	14	10	40	1¼ hrs.
Connecticut	20	14	10	40	1¼ hrs.
Virginia	30	30	10	100	30–40 min.
Ohio	15	15	15	50	1¼ hrs.
Delaware	5	5	5	15	1½ hrs.

The use of salt was largely discontinued after 1906.

Commercial lime-sulfur began to appear in quantities in 1907 and continued to gain favor until it largely displaced the homemade mixtures in 1914.

Dry lime-sulfur appeared in California in 1915.

The almost complete disappearance of the San José scale in the commercial orchards of California by 1914 greatly reduced the use of lime-sulfur as a scalecide. Almost from the beginning, however, it was found to be a very effective fungicide and was very extensively used throughout California for the control of fungous diseases such as curl leaf, peach blight, mildew, and other similar diseases.

In 1902, W. T. Clarke[156] demonstrated its use for the control of the peach twig borer, *Anarsia lineatella* Zeller, and since that time it has been used very effectively for the control of this insect, not only in California, but throughout the United States and Canada and in other countries.

Lime-sulfur was also extensively used for the control of red spiders on citrus trees as early as 1908 and a similar use for the control of red spiders and mites on deciduous fruit trees about the same time. In 1925, the highly refined summer oil sprays practically replaced it for these purposes.

In 1927 lime-sulfur, in California, was largely used as a combined fungicide and insecticide for the control of fungous diseases and the

[155] Quayle, H. J., *op. cit.*, p. 7 (1905).
[156] Calif. Agr. Exp. Sta., *Bul. 144* (1902). He used the 1891 formula.

peach twig borer. For the latter, however, it is often replaced by arsenate of lead on apricot and peach trees to avoid the injuries often occasioned by lime-sulfur. For the same reason Bordeaux

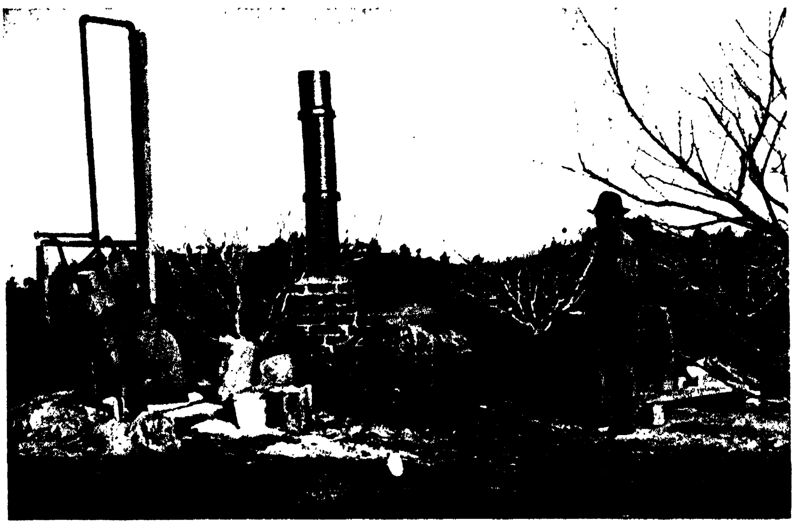

Fig. 142.—Preparing the lime-sulfur wash for the control of the peach twig borer, *Anarsia lineatella* Zeller, in the peach-growing districts of the Sierra foothills, Placer County, California, in 1901.

mixture is also replacing it to a considerable extent for the control of fungous diseases on the same kinds of trees.

In combination with either nicotine sulfate or with certain oil sprays [157] lime-sulfur has also been used for the control of citrus thrips in many parts of the state since 1914.

Carbon Disulfide

Carbon disulfide (carbon bisulfide) was first used as an insecticide by Lazare Gerreau (1812–1892), in 1854. In July of that year "he reported that *sulfure de carbone* was far more effective than any of the other agents tested" against grain weevils. Louis Dayère (1811–1863), often given credit for this discovery, published an account of his discovery of the value of this material as an insecticide in May, 1857. His work was on the control of

[157] With certain of the recently developed highly refined oil sprays, lime-sulfur cannot be used either before or in combination with them.

stored-grain insects in Algiers.[158] It was first tested on the phylloxera by Paul Thénard in France in 1859 and was very extensively used by 1873 and was again tested for its insecticidal properties on the phylloxera and also on other insects in France in 1876.[159]

In America it was "more or less successfully used for the cabbage root-maggot ever since 1880, when A. J. Cook experimented with it with such success that he began to recommend it." [160] In 1894, M. V. Slingerland of Cornell University, experimenting with the same insect, "demonstrated that when properly applied the substance was sure death to the insects and did not injure the plants." In 1901, W. E. Hinds, then temporary assistant of the Division of Entomology, made an extensive study of this chemical as a general insecticide. He reviewed the previous work and conducted a number of experiments, all of which were summed up in the bulletin already referred to.[161]

Carbon disulfide was proposed as a remedy for the grape phylloxera in California by James Blake in 1876 and E. W. Hilgard again emphasized it in 1878, but it was never even extensively experimented with in this connection and therefore was used but little. This fumigant appears to have been first extensively used in California as a remedy for gophers and ground squirrels in the latter year.[162]

It has continued to be used extensively for the control of gophers [163] and ground squirrels [164] in California and it has also been very generally used as a fumigant for warehouses, packing houses, mills, stores, and residences for the control of dried fruit, cereal, and household insects.[165]

[158] Lodeman, E. G., *The spraying of plants* (New York, Macmillan, 1897), p. 135. Simmons, Perez, and Ellington, Geo. W., *The discovery of the insecticidal property of carbon disulphide*, Science, vol. 64, pp. 326–327 (1926).

[159] Hinds, W. E., *Carbon bisulphid as an insecticide*, U. S. Dept. Agr., Farmers' Bul. 145, p. 10 (1902).

[160] Cook first used this material for killing ants in 1888 [Mich. Agr. Exp. Sta., *Bul. 39*, pp. 11–12 (Oct. 1, 1888)] and experimented with the cabbage maggot two years later. [*Ibid.*, *Bul. 58*, p. 10 (1890).]

[161] Hinds, W. E., *op. cit.*, *Farmers' Bul. 145*, 28 pp. (1902). This has been revised as *Farmers' Bul. 799*, 21 pp. (1917).

[162] Hilgard, E. W., *On the destruction of the ground squirrel by the use of bisulphide of carbon*, Calif. Agr. Expt. Sta., Bul. 32 (1878).

[163] Dixon, Joseph, *Control of the pocket gopher in California*, Calif. Agr. Expt. Sta., Bul. 340, pp. 337–350, 5 figs. (1922).

[164] Dixon, Joseph, *Control of the California ground squirrel*, *ibid.*, Circ. 296, 15 pp., 3 figs. (1925).

[165] Essig, E. O., *Important dried fruit insects in California*, State Dept. Agr. Calif., Mthly. Bul., Suppl., vol. 9, pp. 123–124 (1920).

Carbon disulfide has also been used for the control of the pear root aphis, *Eriosoma languinosa* (Hartig), in California from 1914 until it was replaced by paradichlorobenzene in 1921–1922. For this purpose the carbon disulfide was mixed with water in proportion to one fluid ounce to four gallons of water and applied in a basin at the base of the infested trees.

In 1922–1924, F. H. Wymore[166] conducted a number of successful experiments with this chemical for the control of the garden centipede, *Scutigerella immaculata* (Newport), in the asparagus fields of the Sacramento River Delta Region. It has also been used for the control of wireworms, peach borer, and other soil-infesting insects.

In 1922, De Ong and Roadhouse[167] demonstrated its usefulness in effectively controlling cheese mites, *Tyroglyphus siro* (Linn.) and *T. lintneri* Osborn, and the cheese skipper, *Piophila casei* (Linn.), by fumigation.

Carbon disulfide is also used alone or in combination with other chemicals, as a weed eradicator in California.

As a means of destroying the larvæ of the Japanese beetle, *Popillia japonica* Newm., carbon disulfide emulsion has been extensively used and has proved to be of great value for the subterranean forms of many insects.[168]

Miscellaneous Sulfur Compounds

In addition to sulfur, used both in the dry and wet condition, carbon disulfide, used as a fumigant, and lime-sulfur, other compounds of sulfur were also used to a considerable extent in the control of insects in California. In 1880, C. A. Wetmore, chief executive viticultural and health officer of California, prescribed six methods for the treatment of cuttings of grapevines and rooted grapevines to prevent the spread of phylloxera in Cali-

Horne, W. T., Essig, E. O., and Herms, W. B., *Plant disease and pest control*, Calif. Expt. Sta., Circ. 265, pp. 118–119 (1927).

[166] *Biology and control of the garden centipede*, Pomona College, Jour. Entom. & Zool., vol. 16, pp. 73–88 (1924).

[167] De Ong, E. R., and Roadhouse, C. L., *Cheese pests and their control*, Calif. Agr. Exp. Sta., Bul. 343, pp. 399–424, 9 figs. (1922).

[168] Leach, B. R., *Control of Japanese beetle in lawns*, Pa. Dept. Agr., Bul., vol. 8, 12 pp., 6 figs. (Aug. 15, 1925).

Fleming, W. E., *Water and water solutions of organic compounds as dips for the soil of potted plants infested with the Japanese beetle*, Jour. Agr. Resr., vol. 33, pp. 821–828 (1926).

Leach, B. R., Lipp, J. W., and Fleming, W. E., *Control of Japanese beetle grubs*, Pa. Dept. Agr., Bul., vol. 10, 21 pp., 8 figs. (Feb. 15, 1927).

fornia. Two of these were sulfur compounds. **Sulfo-carbonate potash** was recommended at the rate of ten pounds to one hundred gallons of water and sulfide of potash at the rate of one pound to twenty gallons of water. In 1882 sulfo-carbonate of potassium was also recommended as a remedy for the woolly apple aphis.[169] It was poured into a basin at the base of the tree, but was said to be of no value for large trees. Matthew Cooke [170] recommended a number of sulfur compounds by boiling together sulfur, soft soap and concentrated lye, or soap and sulfur. These were applied alone for scale insects, grape leafhopper, aphis, and thrips, or they were combined with other insecticides for caterpillars, beetles, and the eggs of moths.

The Geiger wash, used for the scale insects on deciduous trees during the winter months in 1884–1887, was made according to the following formula:[171]

Concentrated lye	6 pounds
Water	6 gallons
Sulfur	4 pounds

Mix and bring to boiling point; add

Water	9 gallons
Whale-oil foots	3 "
Water	15 "
Saltpeter	3 pounds

Apply hot at 130° F.

The sulfide of potash wash, a modification of the Geiger wash, recommended by E. W. Hilgard in 1896–1898, for moss, fungi, and scales on deciduous fruit trees was made by boiling together for one hour:

Caustic soda (98%)	1 pound
Commercial potash	1 "
Sulfur	3 pounds

To this was added twenty pounds of whale oil soap dissolved in water and the whole mixture boiled together for one-half hour. For use it was diluted to make one hundred gallons of spray, which was applied hot in winter.[172]

These compounds were almost entirely replaced as insecticides by lime-sulfur in 1887 and did not become evident for the control

[169] Gillet, Felix, Calif. State Bd. Hort. Commrs., *First Rept.*, pp. 33–34 (1882).
[170] *Injurious insects of the orchard, vineyard, etc.*, pp. 368–423 (1883).
[171] Klee, W. G., State Bd. Hort. of Calif., *Bien. Rept. for 1885–86*, p. 375 (1887).
[172] Woodworth, C. W., *Remedies for insects and fungi*, Calif. Agr. Expt. Sta., Rept. for years 1895–1896, 1896–1897, p. 229 (1898).

of orchard pests until 1920–1924 when certain proprietary materials known as soluble sulfurs (potassium and sodium sulfides) were recommended for the control of orchard red spiders or mites. They disappeared, however, in a very short time.

SPREADERS

Flour and soap were used during the early development of the arsenical sprays, the former to lessen the injurious effects, and the latter to increase the efficiency of the poisons. So far as I have been able to learn, John Rock of San José in 1886 was the first person in California to use a material for the express purpose of a spreader. He states:

> I find that in spraying it (London purple) the skin of the apple contains oils; the oil repels it; it does not take the water and cover the entire surface. . . . To overcome that, so as to have the poison spread over the entire apple, I dissolved the poison in soap water; beat up the soap to make suds. I put that in the water and it covered the entire apple.[173]

In 1885, C. V. Riley recommended a little flour as an adhesive in a spray composed of one-half pound of London purple to from fifty to fifty-five gallons of water for the control of cotton worms.[174]

In 1905, W. H. Volck, [175] called attention to the use of adhesives as follows: "While lead arsenate is a very great improvement over Paris green in the matter of retention or rain resistance, it may be improved in this respect by adding some adhesive. The resin-soap adhesive has given excellent results in the East. It is prepared according to the following formula:

Pulverized resin	5 pounds
Concentrated lye	1 pound
Fish, or other animal oil (except tallow)	1 pint
Water	5 gallons

"Place the oil, resin, and one gallon of hot water in an iron kettle and heat until the resin softens; then add the lye, and stir thoroughly; now add four gallons of hot water, and boil until a little will mix with cold water and give a clear amber-colored liquid; add water to make up five gallons; keep this as a stock solution, and for use take one gallon of stock solution to twenty-five gallons of arsenate of lead spray mixture.

[173] Calif. Board State Hort. Commrs., *Bien. Rept.*, 1885–1886, p. 212 (1887).

[174] U. S. Entom. Commr., *Rept. 4*, pp. 149–153 (1885).

[175] *Practical suggestions for codling moth control in the Pajaro Valley*, Calif. Agr. Expt. Sta., Circ. 14, p. 8 (1905).

"The flour-paste adhesive so successful in causing the sulfur, used in sulfur spraying for red spider (Bulletin No. 154, California Experiment Station, 1903) to resist the action of the rain, will also answer well here. It is prepared as follows: Take one pound of wheat flour to one gallon of water. Place the flour in a box with a screen bottom (common wire window screening), and pour the water through it until all the flour has been washed into the receiving vessel. It will then be finely divided and free from lumps. The mixture should then be brought to the boiling point, being stirred constantly, thus forming a thin paste without lumps. Use four gallons of this paste to every one hundred gallons of water; run it through a strainer before adding to the spray mixture."

The use of soap in arsenical sprays was not always advisable because of chemical reactions and injuries to fruit and foliage so that this type of a spreader did not become popular. In fact the term spreader did not come into general use until 1918, when A. L. Lovett [176] in Oregon, made a number of tests with casein-lime mixture in arsenate of lead sprays for the codling moth. He found that from four to eight ounces were sufficient for one hundred gallons of spray. The insecticide world was eager for this new information and a great deal of investigational work followed this announcement. Spreaders and adhesives became exceedingly popular and manufacturers of casein filled the markets with the new materials, while the makers of arsenate of lead incorporated them in their products.

Ralph H. Smith [177] did a great amount of investigational work with casein and calcium hydrate spreader in connection with the spraying of apples with arsenate of lead for the control of the

[176] *Jour. Econ. Entom.*, vol. 11, pp. 66–69 (1918). Lovett got the idea from a short article in the *Agricultural Gazette of New South Wales*, vol. 24, p. 868 (1913), which was a translation of the results of some investigations made by V. Vermorel and F. Danthony, in an effort to find substances to make Bordeaux mixture adhesive. Casein was found to be not only the best substance experimented with, but also the least expensive. Three to eight ounces first dissolved in a small quantity of milk of lime, were sufficient for a hundred gallons of spray. It was prepared thus: "Mix intimately 3½ ounces powdered burnt lime and 1½ ounces of powdered casein. Add to the mixture very little water and work it well into a paste. Thin it down with successive small quantities of water till a quart of liquid is obtained, which is then to be added to the Bordeaux mixture." *Jour. d'Agr. Pratique*, t. 1, p. 679 (1913).

[177] *Laboratory experiments relating to codling moth control*, Jour. Econ. Entom., vol. 18, p. 546 (1925).

Is it possible to control the codling moth by spraying?, Wash. State Hort. Assoc., Proc., vol. 21, pp. 80–87, 100–104 (1925).

Can we vanquish the codling moth?, Better Fruit, pp. 5–6, 15 (Dec., 1925); pp. 7, 13 (Jan., 1926); p. 16 (Feb., 1926); pp. 7, 22 (Mar., 1926); pp. 7, 13, 17 (April, 1926); pp. 9, 16 (May, 1926).

The efficacy of lead arsenate in controlling the codling moth, Hilgardia, vol. 1, pp. 403–453, 18 figs. (1926).

codling moth, during the period from 1923–1926. In his laboratory tests he used one pound of the spreader to one hundred gallons of arsenate of lead spray.

The arsenical residue problem which became acute at this time in connection with the marketing of apples and pears sprayed with arsenates for the control of the codling moth, had a marked effect upon the use of adhesives and spreaders and a noticeable decline was at once apparent. Spreaders, however, continue to be used to a considerable extent, and it is difficult to predict the final outcome of their future.

In spraying for leaf-eating insects on woodland trees, ornamentals, and plants where arsenical residue is not a factor, fish oil [178] has been found to be very satisfactory as an adhesive.

Poison Baits

Poison bran mash. The discovery and first use of poison bran mash belongs to the superintendent of the Natoma vineyard near Folsom in Sacramento County in 1885. Concerning this important discovery, D. W. Coquillett reported [179] to C. V. Riley under date of September 1, 1885, as follows:

> About the middle of June the superintendent of the Buhach plantation, G. E. Ladd, who extended to me every facility in his power to aid me in studying up the locust problem in this valley, wrote to the superintendent of the Natoma vineyard, near Folsom, in Sacramento County, asking him what remedies he had used for destroying the locusts, and also what success he had had with them, and received a reply stating that he had been experimenting with a mixture composed of arsenic, sugar, middlings, and water, and was of the opinion that this would prove a decided success.
>
> About this time Messrs. George West and Thomas Minturn, two of the proprietors of the extensive orchard and vineyard of Kohler, West & Minturn, at Minturn Station, in Fresno County, paid a visit to the Natoma vineyard for the purpose of learning more about the above remedy, and were so much pleased with what they saw of its effects upon the locusts that they determined to try it upon their own orchard and vineyard at Minturn Station, and invited Mr. Ladd and myself to visit them and witness the results of the experiments. Accordingly, on the 24th of June, we proceeded to Minturn Station, and from what we there saw of the effects of this remedy, were convinced that it was a decided success.
>
> About the 12th of July, Messrs. Milco & Peters sent to the Buhach plantation 1,000 pounds of arsenic, an equal quantity of sugar, and about 3 tons of

[178] Hood, C. E., *Fish oil, an efficient adhesive in arsenate of lead sprays*, U. S. Dept. Agr., Dept. Bul., 1439, 21 pp., 16 figs. (1926).

[179] *Report on the locusts of the San Joaquin Valley, California*, U. S. Commr. of Agr., Rept. for 1885, pp. 290, 300–302 (1886).

bran, to be used in poisoning the locusts upon about 300 acres of the plantation that were planted out to fruit trees and grapevines. Bran has been substituted for the middlings, not only on account of its being cheaper, but also from the fact that in drying after having been wet, it forms a jagged mass, which offers the locusts a chance to feed upon it whereas middlings, in drying, being much finer than bran, forms a smooth, even mass, which gives the locusts no chance to get a bite of it. During the next two days about two-fifths of the above materials were mixed and put out upon the 300 acres mentioned above, and this was repeated about one week later. After the expiration of a week after this second batch had been put out there were at least 400 dead locusts to every living one.

I remained at the Buhach plantation until the first week in August, when, in accordance with your request for me to return to my home and write my report, I took the train for Anaheim on the 8th of August, and arrived at my destination the next day. A few days before this I paid a visit to Messrs Milco & Peters, at Stockton, but could not prevail upon them to receive any compensation whatever for my board, &c., while at their plantation. During my stay at the plantation these gentlemen did all in their power to aid me in my studies, and Mr. Milco visited the plantation several times while I was staying there, and assisted me much.

A remedy that has been very successful in destroying locusts consists of a certain proportion of bran, arsenic, sugar, and water; these have been used in different proportions, but the one that appears to give the best results consists of 1 part by weight of arsenic, 1 of sugar, and 6 of bran, to which is added a sufficient quantity of water to make a wet mash.

This preparation is usually prepared in wash-tubs or half barrels. One of these is filled about three-fourths full of dry bran, and to this is added about 5 pounds of arsenic, which is thoroughly stirred through the bran with a spade or shovel. Five pounds of sugar is next thrown into a pail, which is then filled with water and the sugar stirred until it is dissolved, when this sugar-water is added to the bran and arsenic and the three well stirred; more water is added and the stirring continued until every portion of the mash becomes thoroughly saturated.

About a teaspoonful of this mash is placed at the root of each tree, shrub, or plant infested with locusts, dropping it in the shade when this can be done. In the case of low shrubs or plants nothing more need be done, as the locusts will find their way to the poison, but when large trees are treated the locusts should be jarred out of them, or be driven out with long poles.

I have known locusts to be killed by eating some of this mash that had been put out over a week previously. The poison works very slowly, and when put out early in the morning will show but little effect upon the locusts until quite late in the day. A devastating locust that I saw eating the mash at 9 o'clock in the forenoon was still alive at 6 in the evening, but was dead when next examined early the next morning.

Allowing a teaspoonful of this mash to each grape-vine in the vineyard—the vines being 7 or 8 feet apart—this will require about 10 pounds of the dry bran (and arsenic and sugar in proportion) to each acre. The cost of the material will vary, but should not exceed 50 cents for each acre of grape-vines,

including cost of labor for mixing and applying it. For orchards the cost will be much less than this.

The addition of sugar to this mash is merely for the purpose of causing the arsenic to adhere to the particles of bran, and not for the purpose of increasing its attractiveness, since bran is more attractive to the locusts than sugar. This I have demonstrated to my own satisfaction. A quantity of sugar was placed upon the ground contiguous to an equal quantity of bran mash; when a locust came to the sugar he would eat a little of it, move on a short distance and again take a few bites of the sugar, and continue in this manner until he reached the mash, when he would settle down, eat his fill, and then move off. The locusts which came to the mash before reaching the sugar would, almost without exception, eat their fill of the mash and then walk away, but occasionally one would leave the mash and take a few bites of the sugar, only to return to the mash again. None of them ate their fill of the sugar, but always manifested an evident preference for the mash.

This mash was used upon about 300 acres of orchard and vineyard on the Buhach plantation, and about two weeks later scarcely a living locust was to be seen where they could have been counted by the hundred or even thousands before the poison had been applied, the ground in many places being literally covered with the dead bodies of the slain.

Several other parties also used this poisonous mash, and so far as I was able to learn, it gave entire satisfaction in every instance.

By exercising only ordinary precautions there need be no fear of endangering the lives of either man or any of the domestic animals in using this poisonous preparation. It should be mixed in a close room to prevent the arsenic from being blown about by the wind. There is no need of touching the arsenic or the mixture with the hands, as the mixing and distributing is accomplished by means of spades, shovels, wooden paddles, etc.

Of course this mixture should not be put out in places where poultry or any of the domestic animals can gain access to it. Upon the Buhach plantation were four greyhounds and several cats that were allowed to roam about the plantation where this mixture had been put out for the locusts; still at the time that I left the plantation—about four weeks after the poisonous mixture had been put out—not one of them had been killed either by eating of the mixture itself, or of the locusts that had been poisoned by it.

There were also several barnyard fowls upon this plantation, but not one of them was poisoned from having eaten locusts that may have found their way to the poultry range after having eaten of the poisonous mixture. Mr. Boynton, whose farm adjoins the Buhach plantation on the west, stated to me that many of the locusts which had eaten of the poisonous mixture would fall into an irrigating ditch that flowed through his poultry yard, and many of the locusts were thus carried within the reach of his fowls; still he was not aware that any of the latter had died from the effects of having eaten of the poisoned locusts.

In fact, I did not learn of a single instance where this mixture had caused the death of any person, nor of any domestic animal, although it was used very extensively in many parts of the San Joaquin Valley. Neither were the birds killed in any considerable numbers from having eaten either of the

mixture itself or of the locusts that had been poisoned by it. During the four weeks following the putting out of this mixture upon about 300 acres of the Buhach plantation, I found only about half a dozen dead birds that had evidently met their death through the agency of this mixture; these consisted of three or four meadow larks, a bee-bird, and a field sparrow.

Rabbits and hares, or "jack-rabbits," as they are commonly called were destroyed in large numbers by this mixture. After the greater numbers of locusts upon the Buhach plantation had been destroyed the work of extermina-

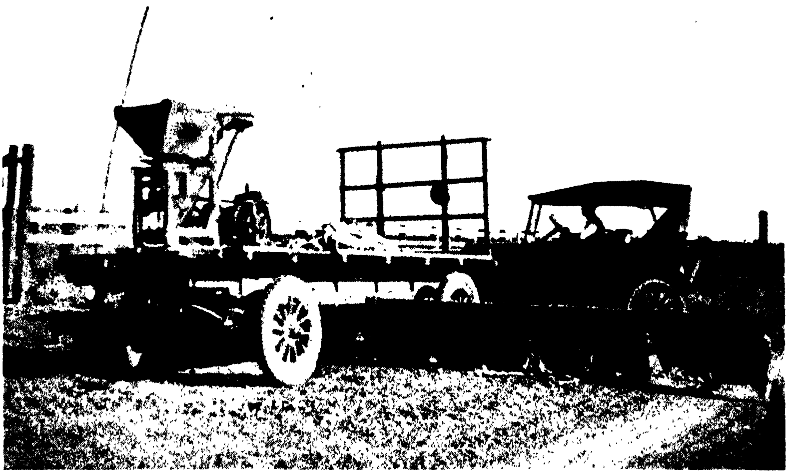

FIG. 143.—A broadcast grain seeder is often used in California for distributing poison bran mash for controlling grasshoppers. This particular outfit was designed to spread the poison bait for the control of the beet army-worm, *Laphygma exigua* (Hbn.), which was seriously injuring young cotton. A lateral boom was added from which sacks were dragged to remove the caterpillars from the plants. (Photograph furnished by J. P. Benson, 1925.)

tion was carried into a large patch of wild sunflowers adjoining the plantation on the north, and as one of the results, at least two dozen hares paid the penalty with their lives.

The four greyhounds belonging to the plantation were among these poisoned hares almost every day; still I never saw one of them attempt to feed upon the poisoned hares; certain it is that not one of them met his death from this cause.

As the mixture is saturated with water before it is put among the plants infested with locusts, there is no danger of its being blown about by the wind; and there is also very little danger of its being deposited upon the fruit by the feet of birds and insects that may have alighted upon the mixture and afterwards flown to and alighted upon the fruit. As the mixture becomes dry its particles adhere together, forming a solid mass which could not be blown about by the wind.

I have never seen this poisonous mixture used in grain fields, but know of no reason why it would not prove very effectual in such fields. Great care should be exercised in using it in alfalfa fields, but if it were placed upon small pieces of boards it could doubtless be used with entire safety in such fields; but of course it would not be safe to pasture any animal in such fields, even after the poison had been removed.

In 1892 poison baits were first used for cutworms in California, the baits consisted of clover or fresh herbage treated with Paris green or white arsenic. This method was used for cutworms in New York as early as 1832.[180]

In 1894, R. C. Allen, Bonita, San Diego County, controlled cutworms by using a poison bait composed of three pounds of Paris green to one sack of rye bran, thoroughly mixed and moistened.[181]

The poison bait did not become popular for the control of grasshoppers until fifteen or twenty years later.

The poison bran mash recommended by the Department of Entomology, University of California in 1905 [182] was made according to an entirely different formula:

Bran	40 pounds
Molasses (cheap)	2 gallons
Arsenic	5 pounds
Water to make a mash.	

The variations in the formula of the poison baits are indicated in the following table:

Year	Bran	Paris Green or White Arsenic	Syrup or Molasses	Water
1885*	6 pounds	1 pound	1 pound	To mix
1905	40 "	5 "	2 gals.	"
1913	25 "	½ "	1 qt.	"
1919†	25 "	1 "	2 qts.	3 gals.
1927	25 "	1 "	2 "	3 to 4 "

* In this first mixture middlings and sugar or syrup were used.

† In this Kansas formula 6 finely chopped lemons or oranges were used. In 1921–1923 amyl acetate, 3 ounces per 100 pounds of dry bran, was extensively used instead of oranges and lemons in the middle states. Alfalfa meal has also been frequently substituted for bran.

In addition to the control of grasshoppers, these poison baits have been extensively used in California for the control of cut-

[180] *Insect Life*, vol. 4, p. 326 (1892).

[181] *Ibid.*, vol. 6, p. 376 (1894).

[182] Hunter, J. S., *Studies in grasshopper control*. Calif. Agr. Expt. Sta., Bul. 170, p. 10 (1905).

worms, particularly in truck and field crops, and for snails, slugs, and sowbugs in truck and flower gardens and in greenhouses and lathhouses.

Hydrocyanic Acid Gas Fumigation of Citrus Trees [183]

The discovery and development of hydrocyanic acid gas fumigation for the control of citrus fruit insects are among the great

Fig. 144.—The Morse generator in which the HCN was generated and forced into the tents by means of a small hand blower. (California State Bd. Hort., 1889.)

achievements in the entomological history of California. The subject is rather an extensive and complicated one and may for convenience and understanding be divided into five periods as follows:

First or experimental period, 1886–1888. First experiments and early development of fumigation. External generator, poor tents, no accurate system of obtaining dosage, daylight work.

Second period, 1889–1906. Pot generation under tents, better tent materials, night work.

Third or standardization period, 1907–1912. Pot generation, marked tents, accurate tent measurements, dosage tables, and standardized equipment.

Fourth period, 1913–1916. Machine fumigation.

Fifth period, 1916–1927. Liquid hydrocyanic acid gas method, calcium cyanide dust.

[183] The author is indebted to R. S. Woglum for reading this portion on Fumigation and for making a number of valuable suggestions relative to the same.

First or Experimental Period, 1886–1888

The cottony cushion scale, *Icerya purchasi* Maskell, was introduced into the citrus orchards of southern California just prior to 1876 and spread very rapidly. Its attacks proved serious to the trees and great damage was apparent in many sections in 1883. To stay its spread and reduce the injuries caused by it, sprays were first advocated for its control, but proved entirely ineffective.[184] The future outlook for citrus culture in California was gloomy indeed and many growers turned to other crops. Because of the seriousness of the situation, C. V. Riley, Entomologist of the Division of Entomology, U. S. Department of Agriculture at Washington, D. C., appointed D. W. Coquillett in 1885 as a field agent of the Division to investigate the pest and devise means of control. Coquillett had been living in southern California since 1882 and was familiar with the problem at hand. Several years prior to 1886 a number of experiments were conducted to control scale insects with gases. Coquillett [185] describes these attempts as follows:

"For this purpose the infested tree was enclosed in an airtight tent the lower part of which was either fastened around the trunk of the tree or allowed

[184] In connection with spraying for this pest in southern California, Alexander Craw gives the following interesting account: [Coquillett, D. W., U. S. Dept. Agr., *Yearbook*, 1877, p. 124 (1888)]. "Previous to the year 1884 we had only the Black Scale (*Lecanium oleæ*), to contend with in the Wolfskill orange groves, and these scales were easily kept in check by an application of whale-oil soap in the form of a spray; one application every two years was sufficient. In the fall of the year 1884 we found a few trees on the south side of the large grove infested with the Cottony Cushion-scale (*Icerya purchasi*); they became infested from an adjoining grove. We prepared for war, and soon had our spraying apparatus at work upon them. As we were in for extermination, we made a very strong solution of the whale-oil soap—so strong it almost defoliated the trees—and upon examination it looked as if we had gotten rid of the *Icerya*. A short time afterward, however, we found that the trees were again infested, and we sprayed again, using as much as 50 gallons of the solution to each tree; but even with all this care, some of the *Icerya* escaped and soon covered the trees again spreading in a northeasterly direction through the grove. We then cut the trees back, letting the branches drop upon a large canvas and afterward burning them; we washed the stubs and trunks of the trees with the whale-oil soap solution, but even this severe treatment was not effective, so we concluded that spraying would not check this prolific creeping curse."

D. W. Coquillett was, however, the first to make extensive experiments with various sprays in 1886. He used caustic potash, caustic soda, hard soap, soft soap, kerosene emulsions, tobacco, tobacco soap, sheep dip, vinegar, and Paris green. [U. S. Dept. Agr., *Rept.*, 1886, pp. 552–557 (1887).] Albert Kœbele succeeded Coquillett in this experimentation and performed 157 experiments with sprays and 6 experiments with carbon disulfide as a fumigant. [U. S. Dept. Agr., *Rept.*, 1886, pp. 558–569 (1887).]

[185] Coquillett, D. W., U. S. Dept. Agr., *Yearbook*, 1887, pp. 123–124 (1888).

to fall upon the ground; in the latter case a small quantity of earth was thrown upon the lower part of it to prevent the escape of the gas or smoke; the tent was then filled with the smoke or gas experimented with.

"Among the first to make experiments of this kind were J. W. Wolfskill and Alexander Craw, of Los Angeles; John Wheeler of San Francisco; J. DeBarth Shorb, J. R. Dobbins, and Mr. B. M. Lelong, of San Gabriel. The substance most commonly experimented with was the liquid disulfide of carbon (CS_2), but this did not prove entirely satisfactory.

"Probably no person has spent more time and money in trying to discover some effectual method for destroying the scale-insects with gas than has J. W. Wolfskill, of Los Angeles."

In describing the early experiments of Wolfskill, Alexander Craw [186] gives the following very interesting account: "Knowing the fatal effects of a high temperature upon the young of the Black Scale, Wolfskill suggested experimenting with heat; accordingly he had a tent constructed, and also a sheet-iron stove that would send the heat into the tent. We put the tent over an orange tree, and raised the temperature to 128° Fahrenheit for over an hour; this killed the Black Scales, but the *Icerya* seemed to enjoy the heat. The tree was injured, so we gave up dry heat. We next tried steam from a small steam-boiler; this cooked the top of the tree, but upon the lower half the *Icerya* were as lively as ever. Our next experiment was with tobacco smoke; this test lasted six hours but had no effect upon the tree or scales. Sulfur fumes were also tried; this bleached the foliage, but did not harm the *Icerya;* a heavier charge killed both the tree and the scales. Among other experiments made under the tent were: Concussion from gunpowder; muriatic acid gas; carbonic acid gas; liquid chloroform, and also the gaseous chloroform manufactured under the tent from chloride of lime and methyl alcohol; arsenic, and other fumes and gases. We had very encouraging results from the liquid disulfide of carbon; when confined for ten, twenty, or thirty minutes, or even for one hour, no satisfactory results were obtained, but when it was confined three hours it killed all of the scales, which soon assumed a pale buff color. The gas, being a very powerful solvent, also acted upon the eggs, and they were destroyed, while the trees were not injured; in fact, a few weeks afterward they started into a vigorous growth. Our efforts were then directed towards evaporating the disulfide quickly; heat, steam-baths, agitation, circulating the air in the tent, exposing the disulfide in shallow pans, and saturating sponges with it were tried, but without hurrying matters much.

"D. W. Coquillett was so well impressed with our method of treating trees that he decided to investigate the subject; accordingly, in the month of September, 1886, he began experimenting in the Wolfskill orange grove, and soon discovered that hydrocyanic acid gas would kill the scales and their eggs, but it also injured the foliage of the tree. We then united our efforts to remedy this evil, but it was something that required very close observation. We found that by withholding the water and allowing the sulfuric acid to come in contact with the dry cyanide of potassium in a fine stream we could treat trees without injuring even a blossom, while the gas proved fatal to the black scale (*Lecanium oleæ*), red scale (*Aspidiotus aurantii*), and the San José

[186] *Ibid.*, p. 124.

scale (*Aspidiotus perniciosus*) confined in it ten minutes, but the cottony cushion-scale (*Icerya purchasi*) and eggs required a confinement of nearly thirty minutes.

"We then perfected an apparatus for putting the tent on tall trees quickly. This occupied a great deal of time, but we finally succeeded so well that we could change the tent from one tree to the other in less than two minutes. A. B. Chapman and L. H. Titus, of San Gabriel, became impatient at the delay and requested Hilgard, of the State University, to send them a chemist, and they would pay his expenses. In the month of April, 1887, F. W. Morse was delegated for this purpose, and he, too, finally discovered that hydrocyanic acid gas would kill the scales; but Coquillett had made the same discovery over six months previously, so that the credit of this discovery belongs to this latter gentleman. Much credit is also due to J. W. Wolfskill for the great amount of time and money that he has devoted to this cause."

During the year Coquillett was working with Wolfskill he was dropped from the pay roll of the Division of Entomology for lack of funds, and devoted his entire time to the tests on the Wolfskill ranch. His discovery was guarded with secrecy for it was well known that any successful method of dealing with the scale would be sought by the growers at any cost. When it was rumored that a process of fumigation had been discovered, orange growers became anxious to know the method and a group in the San Gabriel Valley consisting of A. B. and A. Scott Chapman, L. H. Titus, and J. C. Newton requested the Agricultural Experiment Station of the University of California "to conduct experiments with the view of determining the efficacy of certain gases as insecticides—with special reference to the white scale, *Icerya purchasi*." E. W. Hilgard, Director of the Experiment Station, sent a chemist, F. W. Morse, to make tests in southern California in 1887, or about six months after Coquillett's discovery. Morse, independent of Coquillett's experiments, set about to test out a large number of gases, including chlorine, carbon disulfide, sulfureted hydrogen, ammonia, carbon monoxide, oxalic acid, carbolic acid, and hydrocyanic acid. In reference to the latter he reported as follows: [187] "It was only with hydrocyanic, or prussic acid (generated by the action of sulfuric acid on potassium cyanide), that sufficiently fatal effects were secured to warrant a more thorough determination of the time of exposure and quantities of material which would produce the best results. Numerous experiments were carried on for this purpose, and it was shown that even small amounts were

[187] *The use of gases against scale insects*, Calif. Agr. Expt. Sta., Bul. 71 (June 12, 1887).

effective. It was also shown that even in these small quantities an injurious effect upon the foliage was produced. In the beginning of the experiments, 'mining cyanide' of potassium was used. It was a very impure material and contained, along with the cyanide, a

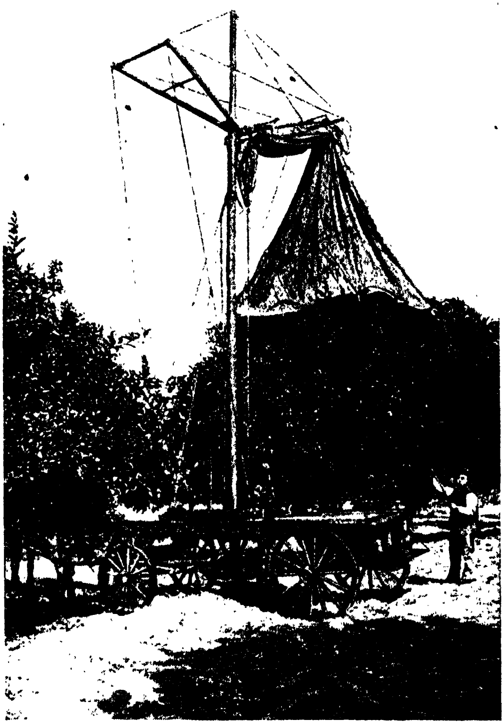

FIG. 145.—The Wolfskill fumigator, designed by J. W. Wolfskill and Alexander Craw, Los Angeles, to fumigate large seedling orange trees. (After C. V. Riley, 1888.)

considerable amount of carbonate of potassium. For this reason many of the first treatments were practically ineffective.

"Later treatments with pure cyanide were more successful in destroying the insects, but the foliage was proportionally injured. Treatments varying in dose from 4 to 12 ounces of cyanide, and in time from 15 to 60 minutes, showed that the effect produced on the foliage by longer treatment was not proportionally greater than

that produced by short treatment. Neither was the effect of longer treatments proportionally more fatal to the insects. It was thus clearly shown that the gas mixture should be of considerable strength in order to insure rapid action.

"The effect of the gas was so disastrous to the foliage that it became necessary to find some means of remedying this trouble. This was sought in applying a second gas, which might preserve the foliage. Sulfureted hydrogen was therefore injected into the tent, together with the cyanide gas, both from the same generator; a portion of the sulfureted hydrogen being introduced before the cyanide was generated. It was found that the insects appeared stupefied when the tent was raised, but large numbers revived in a few hours. The effect of the cyanide seemed therefore to have been decreased by the sulfureted hydrogen. The foliage was not preserved, although not so badly affected as by treatments with cyanide alone.

"Carbonic acid gas was next tried. Trees were treated with larger doses of cyanide than heretofore used, and the carbonic acid from $1\frac{1}{2}$ pounds of carbonate of soda was at the same time introduced with these doses. The insects were killed and the foliage of a 12-ft. tree remained unharmed, while that of a 14-ft. tree with the same amount of carbonic acid was slightly injured. Thus it was shown that it would require $1\frac{1}{2}$ pounds of bicarbonate of soda to preserve tree-tops 12 feet in diameter, and that with this protection the deadly cyanide could be successfully used.

"The regulation of the doses for the different sized trees so as to produce uniform treatments was calculated on the basis of the results of the experiments which determined the amount of each constituent for a 12-foot tree. A table was formulated indicating the amounts for trees of different dimensions of top, based upon the rates of cubical contents.

"In order to apply doses easily they are prepared so that the required amounts of each ingredient can be directly measured. The cyanide solution is prepared by dissolving say 10 pounds of solid salt in about $2\frac{1}{4}$ gallons of water, warmed nearly to the boiling point, stirring at intervals, cooling, and then diluting to $2\frac{1}{2}$ gallons. This solution will contain about one ounce of cyanide of potassium to $2\frac{1}{2}$ fluid ounces of the liquid.

"The bicarbonate of soda is pulverized finely and measured off in a vessel marked, so as to designate pounds and fractions of a pound of the solid material. It is then placed in the generator and the dose of cyanide mixed with it into a thin paste. After adding the measured dose of sulfuric acid, the

pump is worked slowly at first, and more rapidly after the gas has passed into the tent. The time for each treatment must be determined by future experiments; 15 minutes seemed to be quite sufficient when the cyanide alone was used, but it may be desirable to extend the treatment to 30 minutes when the foliage is protected by the carbonic acid gas.

"It is advisable that the treatments should follow cultivation after about four days, so that all weeds and places where the insect may find lodgment

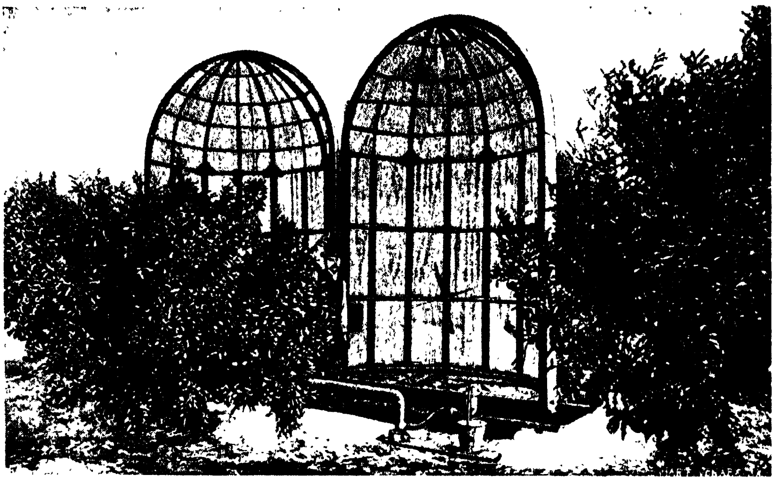

FIG. 146.—The Culver fumigator, devised by John P. Culver, Los Angeles, and patented in 1887, consisted of two half domes, hinged so as to enclose a tree. A fan to circulate the gas within and a small outside gas generator are shown. (After C. V. Riley, 1889.)

would be destroyed. The insect will then be on, or very near, the tree; the fitting of the tent to the ground is thus also much easier.

"The eggs of the insect remained apparently uninjured, wherever protected by the woolly covering. A second treatment, to destroy such as may afterward hatch, will therefore be necessary.

"It must not be understood that these experiments definitely settle the mode of operation and the size of the doses to be used. They are merely suggestive of a general plan which can be so perfected in the future that the application of this remedy to other kinds of trees and insects must be attended with good results. It simply remains for the ingenious cultivator to devise the necessary appliances for its use, on a small scale, on all sorts of fruit trees, shrubs and plants.

"It must not be forgotten that extreme care in the handling both of this deadly gas and of the cyanide itself is necessary. To inhale the one, or to taste or touch a wound with the other, may lead to serious consequences."

Thus it is evident that while Coquillett was experimenting in secret, Morse somehow hit upon the same method and was the

first to publish his findings. There followed an attempt on the part of the original discoverers to patent the process, which attempt was opposed by the fruit growers and by C. V. Riley with the result that no one derived any financial gain from the discovery. The Board of Horticultural Commissioners of Los Angeles County were so satisfied with the experiments conducted by Morse that they secured the necessary financial aid from the Board of Supervisors to complete the work. Accordingly Morse continued the experiments which were published in August, 1887.[188] In this work cyanide of potassium was dissolved in water in proportions of ten pounds to two gallons. Bicarbonate of soda was also used to lessen the effects of burning, but one-fourth less than formerly used was found sufficient. The prescribed doses recommended were tabulated for convenient use. The mode of operating was:

Place the desired amount of acid in the acid receiver, then put the required amount of soda in a convenient vessel (a gallon measure serves the purpose well) and add water to bring it to a thin paste, stirring well to get rid of all the lumps, before the cyanide solution is added. Mix the cyanide solution and the soda paste so that the undissolved soda will remain evenly distributed through the mixture. Pour into the cyanide receiver and allow it to run slowly and regularly upon the acid which has previously been run into the generator. As soon as the cyanide solution begins to enter the generator, the blower should be turned slowly and continued until all the material is run in and violent action ceased. This usually takes a minute or so after the materials have united. Then follow with violent blowing for a minute or so and allow to rest until about 15 minutes from the beginning of the treatment, when violent blowing is repeated for one minute. The time occupied in running in the mixture varied for the different sized trees from four minutes for a 10-foot tree to ten minutes for an 18-foot tree.

It is quite important that the time of injecting shall be closely observed, and should be lengthened rather than shortened. No time will be saved by hurrying this part of the treatment, for if run in too fast lumps will be formed which will take some time to be completely acted upon by the acid. If the time is slightly lengthened no serious results will follow. Some of the largest doses have been completely acted upon in less than 15 minutes, thus making it possible for a single generator to serve two tents when the prescribed time of exposure is adopted. It is advisable to continue the treatment of a single tree for about 30 minutes, although the time may be slightly shortened when two tents are used.

Treatments were made from an exterior generator and during the daytime.

[188] Morse, F. W., *Use of hydrocyanic acid against scale insects*, Calif. Agr. Expt. Sta., Bul. 73 (Aug. 27, 1887).

Coquillett resumed his position in July, 1887, with the Division of Entomology and continued his work with hydrocyanic acid gas fumigation but did not publish his first report until 1888.[189] In this report he calls attention to the fact that the "process of destroying insects on plants in hothouses by fumigation with sulfur, tobacco, and various other substances, has long been in vogue, but up to a recent date this mode of warfare against insect pests has not been extended to trees and plants growing in the open air." On the 14th of May, 1857, James Hatch of Lynn, Massachusetts, obtained a patent which related particularly to the control of cankerworms by enveloping the tree with thin cloth and generating, by means of a heated furnace near the tree, smoke of tobacco, pepper or other substances in a pan which was thrown into the tent thus liberating the fumes and killing or dislodging the worms. This method, however, was neither known nor used. In 1877, George Dimmock[190] made a number of experiments with various gases to kill insects, spiders, and sowbugs, but he did not try hydrocyanic gas. In California, J. W. Wolfskill and Alexander Craw made some extensive experiments with heat, steam, and different fumigants for the control of the cottony cushion scale as did also Albert Kœbele[191] and a number of others. The tent used by Coquillett was made of heavy bedticking treated with boiled linseed oil. The McMullen tent devised by W. G. McMullen of Los Angeles consisted of a frame covered with an oiled tent, slit on one side to admit a tree not over twelve feet high and afterwards made tight to prevent the escape of gas. The Wolfskill fumigator, designed by J. W. Wolfskill and Alexander Craw of Los Angeles, consisted of a derrick mounted on a wagon and a bell tent with an iron hoop at the bottom. It dropped the tent over the tree and was operated by block and tackle and commonly known as the California tree fumigator (Fig. 145). The Titus fumigator devised by L. H. Titus of San Gabriel was a large square frame mounted on six wheels with a large tent in the middle which was operated by ropes, pulleys, and rollers, and dropped the tent over the tree from above. The Culver fumigator (Fig. 146), invented by John P. Culver of Los Angeles, was entirely different from either of the other two. It consisted of two half tents, hinged at the back and brought together

[189] *Report on the gas treatment for scale insects*, U. S. Dept. Agr., Rept., 1887, pp. 123–142, pls. 4–6 (1888).
[190] *Psyche*, vol. 2, pp. 17–22 (March, April, 1877).
[191] U. S. Dept. of Agr., *Rept.*, 1886, p. 569 (1887).

to inclose the tree. The two halves were first framelike, covered with oiled cloth and the whole dome shaped and mounted on sled runners. Later all of the frame excepting the two arches were omitted in its construction. In all of these fumigators the gas was generated outside and conducted into the tent by means of a metal tube.

In the course of his work Coquillett found that gas generated with more water than absolutely necessary produced a wet gas which was very injurious to the foliage of the tree. To remedy this three processes were evolved: "the *dry cyanide* process, which consists of acting upon dry potassium cyanide with sulfuric acid; the *dry gas* process, consisting of acting with sulfuric acid upon potassium cyanide dissolved in water and passing the gas into sulfuric acid; and the *cyanide and soda process,* which consists of mixing bicarbonate of soda with potassium cyanide dissolved in water and adding the mixture to sulfuric acid." The last process was the one previously recommended by F. W. Morse. Various methods were used to agitate the air and gas in the tent such as drawing out the air at the top when the gas was admitted at the bottom, fans, bellows, and mine blowers. General procedure and dosage tables are also given. In all Coquillett lists 130 experiments in this paper.

A supplementary report [192] giving the results of analyses of certain brands of cyanide and details in the generation of hydrocyanic acid gas soon followed.

In 1888 W. G. Klee,[193] State Inspector of Fruit Pests, gave a résumé of the work done by Morse and Coquillett.

Further and final experiments by Morse [194] led him to believe that ammonia, formed in the generation of the gas, was the chief cause of the injuries to the trees and that such injuries could be reduced to a minimum by using the dry gas process as recommended by Coquillett. The work of Coquillett continued unabated. In 1889 he published two papers [195] in the first of which he describes the generator and Leefeld fumigator, lists five brands of cyanide, records the experiments with arseniureted hydrogen gas as an

[192] *Insect Life,* vol. 1, pp. 41–42 (1888).

[193] State Bd. Hort. of Calif., *Third Bien. Rept.,* pp. 242–258, pls. 1–8 (1888).

[194] *Experiments on the cause and avoidance of injury to foliage in the hydrocyanic gas treatment of trees,* Calif. Agr. Expt. Sta., Bul. 79 (May 5, 1888).

[195] *Report on various methods for destroying scale insects,* U. S. Dept. Agr., Rept., 1888, pp. 123–130 (1889).
Hydrocyanic acid treatment for scale insects, Insect Life, vol. 1, p. 286 (1889).

insecticide, and gives a revised dosage table. He also speaks of some experiments on killing red scale, *Chrysomphalus aurantii* (Mask.), which is also briefly discussed in the second paper. Thus ended the first period in the history of fumigation with HCN gas. It marked the crude beginnings with thin, oil-treated tents, daytime work, external generators, cyanide of poor quality, unwieldly derricks and fumigators, and much injury to the trees.

Second Period, 1889–1906. Pot generation, night work

The second period began with some experiments in Orange County in reference to red scale, which, although introduced later, was becoming as injurious as the cottony cushion scale. The work was done in the orange orchard of A. D. Bishop and was participated in by Bishop and by Coquillett, who was invited for consultation and help. The results obtained by this group during 1889–1890 were as follows:

(1) The use of a black tent during the day.
(2) The substitution of night work for day work.
(3) Pot generation of gas beneath the tent.
(4) A change of formula and reduction of dosage in the proportions of one ounce of dry potassium cyanide, one fluid ounce of sulfuric acid, and two fluid ounces of water.
(5) The use of sheet duck tents.

The plain statement of these facts does not disclose the controversy which ensued between Bishop and his associates on the one hand and Coquillett on the other. The points of contention were: (1) discovery of night work, (2) the new formula, (3) new method of generating the gas. Coquillett was the first to record the new discoveries in print.[196] Bishop, however, was granted a patent on night fumigation or fumigation "in the absence, substantially, of the actinic rays of light," in spite of the vigorous protests of Coquillett, Riley, and the fruit growers of southern California, most of whom ignored the patent claims.[197]

[196] *The use of hydrocyanic acid gas for the destruction of the red scale*, Insect Life, vol. 2, pp. 202–207 (1890).

[197] This resulted in a suit in which the "patentees decided to test the validity of their patent in the courts, and in the autumn of 1893 caused the arrest of one of the fruit growers, charging him with the unlawful use of their patent, and seeking to obtain from him not only the first cost of the patent right but also the value of the profits that had accrued to him as a result of his having used the process covered by their patent. The organization of fruit growers alluded to above then employed the proper counsel to represent them before the court, and in due time the trial took place, resulting in rendering the decision . . . to the effect that the patent

Coquillett summarized his work in several articles in the years 1891-1893.[198]

This practically finished the work of Coquillett. The introduction of the vedalia from Australia into southern California in 1892-1893 occupied all of his time in rearing and colonizing the beetles in the infested orchards and in checking the results.

B. M. Lelong [199] gave a résumé of the work up to 1890 and Alexander Craw followed with a short article in 1891 [200] and a more

FIG. 147.—Improved apparatus for HCN fumigation in 1897. A string of bell tents, scales for weighing the cyanide, acid and water measurers, and ordinary white porcelain chamber pots as generators, made up the equipment. Dosages were estimated according to the size of the tree. (Calif. State Bd. Hort., 1899.)

extended discussion in 1894 [201] relative to the poisonous nature of the gas, methods of generation, dosage tables, tents, and the methods of treating tent cloth.

The use of HCN for the disinfection of nursery stock, cuttings,

is not valid." This decision was handed down on April 9, 1894, by Judge E. M. Ross of the Federal Court for southern California. [Coquillett, D. W., *Insect Life*, vol. 7, pp. 257-258 (1894).]

198 *History of the hydrocyanic gas treatment for scale insects*, Insect Life, vol. 3, pp. 457-460 (1891).

Hydrocyanic acid gas as an insecticide, *ibid.*, vol. 6, pp. 176-180 (1893).

199 *Improved fumigating apparatus*, State Bd. Hort. of Calif., Rept., 1890, pp. 469-472 (1890).

200 *Destructive insects, their natural enemies, remedies and recommendations*, Calif. State Bd. Hort., 51 pp. (1891).

201 *Gas treatment for destroying scale insects upon citrus trees*, State Bd. Hort. of Calif., Rept., 1893-1894, pp. 105-109, pls. 37-38 (1894).

grafts, and fruit pits was required by the State Board of Horticulture of California in 1891.[202] Howard subsequently suggested it to eastern nurserymen in September, 1894.[203] J. B. Smith [204] published Howard's suggestion in the same year and it was in general use for this purpose throughout the country by 1896.[205]

The entire subject of orchard fumigation was summarized and brought up to date in 1899 by C. W. Woodworth,[206] who concluded with the following résumé:

> Hydrocyanic acid is the most effective insecticide known.
>
> Its value was first made known by a publication from this station.
>
> Injury to foliage can be prevented in a number of ways.
>
> Night work has proven to be a most important item.
>
> The tent and other apparatus has gone through an interesting course of development.
>
> The dose of cyanide recommended has varied considerably, but the original prescription is about right.
>
> The tent as now made is of light duck, oiled, sized, and painted, or treated with cactus juice to make it gas tight.
>
> Bell tents operated in pairs by means of derricks are much used for the largest trees.
>
> Hoop tents are most used and can be moved from tree to tree with great facility.
>
> Box tents are a recent eastern device having some good points and should be tried here.
>
> Sheet tents are held in great favor and may replace all other kinds.
>
> Fumigating according to a well-arranged plan makes the labor a small item in the cost.
>
> Accurate estimation of the area of the tent is essential to successful fumigation.
>
> The danger from poisoning is chiefly when charging the generator.
>
> The tents must be inspected daily and kept gas tight.
>
> Fumigation may finally entirely replace spraying for scale insects.

Two other papers by Woodworth [207] rounded out and completed the second period.

The latter was a revision of his previous paper with additional information relative to schedules and tent measuring. After this

[202] *Ann. Rept.*, 1891, pp. 29–30 (1892).
[203] Howard, L. O., U. S. Dept. Agr., *Yearbook*, 1899, p. 151 (1900).
[204] N. J. Agr. Exp. Sta., *Bul. 106* (Nov. 22, 1894).
[205] Howard, L. O., and Marlatt, C. L., U. S. Dept. Agr., Div. Entom., *Bul. 3* n. s., pp. 59–61 (1896).
[206] *Orchard fumigation*, Calif. Agr. Expt. Sta., Bul. 122, 33 pp., 22 figs. (1899).
[207] *Fumigation dosage*, Calif. Agr. Expt. Sta., Bul. 152, 17 pp. (1903).
Fumigation practice, *ibid.*, Circ. 11, 25 pp., 24 figs. (1904).

there was a decided lull in the further development of orchard fumigation.

Third or Standardization Period, 1907–1912. Pot generation, marked tents

The third period in the history of fumigation in California was due to the increasingly poor results secured by the methods in use at the time and the requests of state, county, and local parties to the Bureau of Entomology for a more thorough investigation of the whole subject. The investigations were planned to cover the following points:

1. To eliminate guesswork in determining a more exact dosage.
2. To study the chemistry of fumigation.
3. To determine the physiological effects of HCN on the foliage and fruit of the trees.
4. To improve the mechanical equipment.

This is the most important period in the history of fumigation in California, because in it were established the fundamental principles of exact dosage, tent leakage, and the development of adequate equipment (Figs. 148–149).

There is much confusion in the published literature as to how and by whom these important contributions were made and I have endeavored to get at the facts in so far as they are available. All admit that most credit is due R. S. Woglum for the splendid piece of work done by him.

By 1907 it was apparent to the citrus growers of southern California that the entire system of fumigation, as then practiced in the state, required a complete and thorough overhauling in order to eliminate the guesswork in determining dosages, and to prevent the often occurring serious injuries to the treated trees.

Among the leaders of the fruit growers the most influential was G. Harold Powell, manager of the California Fruit Growers Exchange. He had already shown the great losses growers incurred from decay, following the washing of smut-covered fruit as well as from fruit infested with scale insects. J. W. Jeffrey, Horticultural Commissioner of Los Angeles County, and A. J. Cook of Pomona College and a leader of farmers' clubs in southern California, also championed the need of such investigations.

Recognizing the importance and justice of the requests, C. L. Marlatt, acting chief of the Bureau of Entomology, selected R. S.

Woglum to conduct the investigations. Concerning the beginnings of this work Woglum has furnished me with the following statement:[208] "The original correspondence which was given me in Washington in 1907 emphasized the unsatisfactory fumigation condition then prevalent, and the poor results, and requested a scientific investigation of the whole subject, to determine if fumi-

FIG. 148.—The fumigation supply cart came into being following the introduction of marked tents and measured dosages in 1908. The first wagons were drawn by hand. This is a more improved type. The men are replenishing the acid, water, and cyanide. The fact that fumigating work is done at night is emphasized in this picture.

gation could not be improved. Stress was laid on (1) dosage, and (2) physiological studies: equipment was not mentioned.

"My selection for the fumigation investigation in California was not because of any prior experience in fumigation, but because of the fact that I had specialized in the study of scale insects, which fact was well known to Marlatt. My instructions, on taking up this California work, a copy of which is very probably on file in the U. S. Bureau of Entomology, was to proceed to California, look up Jeffrey, Horticultural Commissioner of Los Angeles County, and others who were interested in fumigation, and then investigate the subject along the lines which this examination determined should be investigated.

"My first three months in California were spent in an examination of citrus pest conditions in every citrus growing district of the state, and conferences with every inspector and commercial fumigator then engaged in pest control.

[208] Letter dated at Los Angeles, February 3, 1928.

Following this preliminary work I conducted during the fall of 1907 experiments at the County Farm and in Sierra Madre in Los Angeles County and also at Orange in Orange County. The basis of this project as outlined by me at the start was: (1) Develop an exact dosage basis by eliminating guesswork; (2) Chemistry of fumigation; (3) Physiological effects; (4) Equipment. The first object was to discover the actual dosage required to kill scale insects; the first work being done against the purple scale and red scale. My field studies, together with a study of Woodworth's [209] bulletins, indicated to me that it was necessary to dose trees in proportion to their cubical contents, and the figure approximated by tented trees was a hemisphere topping a cylinder. One of the first things I did was to work out a formula to ascertain the cubic contents of any size tree and then prepare a chart which included the contents of a wide range of trees. Woodworth's fishpole idea of measuring the tops of the trees was adopted with the exception that I used a tape line from the first, throwing the tape over the tree with a rock attached to one end, thereby measuring the distance over and subsequently the distance around. During these experiments carried on during the 1907 autumn it was discovered that large trees gave a far better kill when the dosage was in proportion to the cubical contents than happened in the case of small trees at the same dosage rate. Subsequent experiments in which the work included some very large trees and small trees, developed that there was a very important leakage difference between the two size trees.

"In connection with our work I had outlined chemical experiments as regards the proper proportion of cyanide, sulfuric acid and water which were carried on in Washington. While engaged in the primary problem of development of a dosage schedule based on both leakage as well as cubical contents and working on details of equipment and procedure, I received a telegram from Marlatt, December 23, 1907, to go to Florida at once to show Morrill [210] how fumigation work was done in California. In short when departing for Florida our California work had already been outlined along the course it was to pursue and deviated in no way from this course on my return. I spent the months of January and February in Florida with Morrill; together we fumigated two or three orchards. It was here that the marked tent first came to my attention and during my sojourn there I naturally learned about Morrill's fumigation work. I had, however, been entirely without information about this work until this trip to Florida. On my return to California one of the first things I did was to mark our experimental tents. This marked tent was the one important point in fumigation which I secured in Florida, and took the place of the tape line method which I had been using.

"Because of the fact that Morrill invented the marked tent [211] and that I

[209] C. W. Woodworth was first to recommend a dosage system based on the dimensions of the tent over the tree, Calif. Agr. Expt. Sta., *Bul. 152*, p. 5 (1903).

[210] A. W. Morrill, special field agent of the Bureau of Entomology, conducted a splendid piece of fumigation work in Florida during the years 1906 to 1908. His results were published in a bulletin entitled: *Fumigation for the citrus white fly*, U. S. Dept. Agr., Bur. Entom., Bul. 76, 73 pp., 11 figs., 7 pls. (1908).

[211] Various kinds of marked tents had previously been used by Woodworth [Calif. Agr. Expt. Sta., *Bul. 152*, p. 15 (1903)], and others, but this was the first system that achieved general use in orchard practice.

have always stressed the importance of this invention and introduced it into California, it has sometimes been stated that the system of fumigation which I developed here originated in Florida. All I can say is that the system of fumigation which I developed here would have been developed exactly the same, even though I had not gone to Florida, and even though no marked tent had been invented. I was following, at the time I went to Florida, all

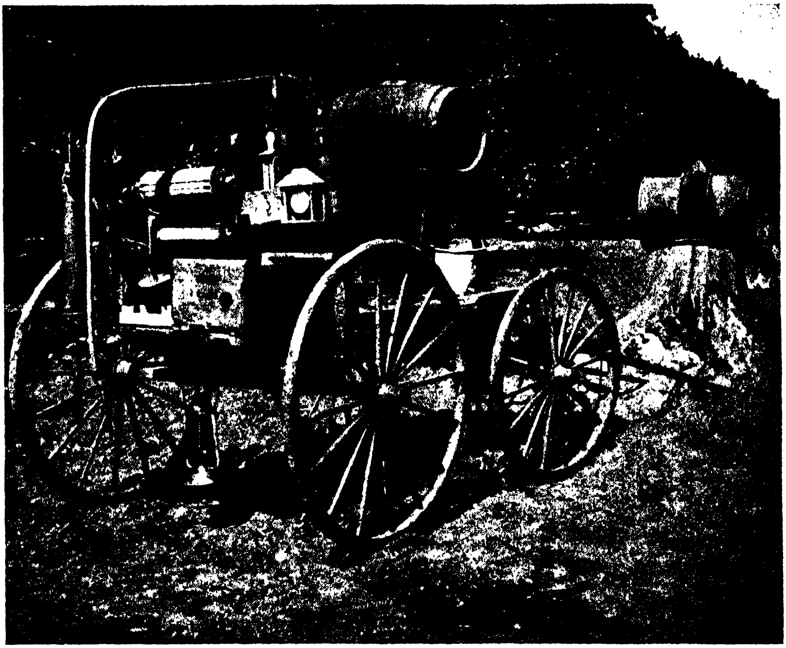

FIG. 149.—The fumigation supply wagon, fully equipped and at its best in 1912, with water barrel, sulfuric acid carboy, thermometer, clock, dosage charts in special containers, scales, liquid measurers, lantern, etc.

the outstanding points of a fumigation procedure except that I was using a tape line to get the distance over the top rather than a marked tent. There is no doubt that the marked tent was the cornerstone on which practical fumigation was built. The tape line was too slow, and to speed it up would have required an extra man. Furthermore, I believe, it would have been next to impossible to 'put over' a system in California with such a cumbersome method of obtaining dosage. While the introduction of the marked tent, and prying fumigation loose from the old guesswork was an uphill struggle, it was the psychology of the marked tent really that ultimately compelled the change.

"As to the dosage schedule, this was in the process of development when I went to Florida and by the summer of 1908 a preliminary schedule had been developed. In July, 1908, two outfits of the Whittier Citrus Association were using my fumigation schedule and procedure, which was three or four months prior to the issuing of Morrill's Bulletin 76, which first presented his dosage

schedule and Florida results. My own dosage schedule was worked out strictly on the basis of my field results out here and bore no relation to the Florida work as an examination of my first day's schedule on pg. 65, Bulletin 79 to the Morrill dosage schedule, Bulletin 76 shows. Subsequently this schedule was modified to some extent, where the practice showed such unnecessary. The last modification in 1918 perfected the schedule which has been uniformly satisfactory since.

"Commercial fumigation was never practiced in Florida. The only tents in Florida in 1907 were those of the Bureau of Entomology. Subsequently the Winter Haven Citrus Assn. purchased a small outfit but they were not used. Recently commercial work has been attempted by cyanide manufacturers."

When Woglum started his investigations in California in July, 1907, the following scale insects were present in the citrus orchards: The black scale, hemispherical scale, soft brown scale, citrus mealybug, cottony cushion scale, [212] red scale, yellow scale, purple scale, ivy scale, greedy scale, and the chaff scale. In addition to the dosage charts, Woglum should be credited with the invention of a field chemical cart, a standard pot generator, and a large number of other improvements for handling the materials in the orchards. His results were published in 1909.[213] For several years the work was continued in southern California by Woglum, the results of which, to use his own words, "have very little of the nature of original discoveries, although there has been acquired a vast amount of exact information never before thoroughly understood. The advance is largely the result of correcting, correlating, systematizing, and placing upon a more scientific as well as a more practical basis, methods which had been practiced in California or elsewhere for many years." Testing new tent materials, gas proofing, mildew-proofing and marking of tents were the important contributions as published in 1911.[214] In 1909 [215] Woglum found

[212] This species was still efficiently controlled by the vedalia, which, however, was often difficult to find and introduce into the infested orchard just when needed. Whenever the vedalia destroyed the scale, it either deserted the orchard or perished and if the scale became reëstablished in later years it was not always immediately followed by the ladybird, which was then obtained in other orchards.

[213] *Fumigation investigations in California*, U. S. Dept. Agr., Bur. Entom. Bul. 79, 73 pp., 27 figs. (1909).

[214] Woglum, R. S., *Fumigation of citrus trees*, U. S. Dept. Agr., Bur. Entom. Bul. 90, pt. I, 81 pp., 12 figs., 8 pls. (1911).

[215] C. P. Lounsbury, government entomologist, first called attention to the use of sodium cyanide for orchard fumigation in 1905.

Woglum, R. S., *The value of sodium cyanide for fumigation purposes*, Jour. Econ. Entom., vol. 3, pp. 85–88 (1910); *ibid.*, U. S. Dept. Agr., Bur. Entom., *Bul. 90*, pt. II, pp. 83–90, pls. ix–x (1911).

Essig, E. O., *The use of sodium cyanide*, P. C. Jour. Entom., vol. 3, pp. 385–389, fig. 133 (1911).

that a highly refined sodium cyanide, so called 124% pure, could be used equally well as potassium cyanide 98 to 99% pure, providing the formula be changed to 1 ounce of sodium cyanide, $1\frac{1}{2}$ fluid ounces of commercial sulfuric acid and 2 fluid ounces of water. A new dosage schedule was also necessary. A large number of articles on various phases of fumigation followed during the next few years but all had to do with improvements of methods, particularly tent materials, tent leakage, chemistry of HCN, effects of the gas on the trees and fruit, and dosages.[216]

Fourth Period, 1913–1916. Machine fumigation

The fourth period in orchard fumigation was brought about by the invention and development of portable fumigating machines which entirely changed the mechanics of fumigation practices. By some it was thought to be the greatest step[217] made since the first experiments in 1886, although in the use of a generator outside the tent, it is a returning to methods first employed by Coquillett. Up to this time the HCN was generated by mixing together, in early days, in a crude generator outside the tent, and in later years in a pot beneath the tent. The last method resulted in much injury to the tents because of the contacts with acid and at best a string

[216] Woodworth, C. W., *Fumigation scheduling*, Calif. Agr. Exp. Sta., Circ. 50, 24 pp., 14 figs., 2 charts (1910).
Dosage tables, *ibid*., Bul. 220, 33 pp., 3 figs., 1 chart (1911).
Leakage of fumigation tents, Jour. Econ. Entom., vol. 4, pp. 276–380, pl. 15 (1911).
A new leakage gauge, Calif. Agr. Expt. Sta., Circ. 75, 15 pp., 8 figs. (1912).
McDonnell, C. C., *Chemistry of fumigation with hydrocyanic acid gas*, U. S. Dept. Agr., Bur. Entom., Bul. 90, pt. III, pp. 91–105, fig. 13 (1911).
Sasscer, E. R., and Borden, A. D., *Fumigation of ornamental greenhouse plants with hydrocyanic-acid gas*, U. S. Dept. Agr., Bul. 513, 20 pp., 4 figs. (1917).

[217] In commenting upon the importance of the fumigating machines, Woglum writes: "Really when you analyze the actual value of the portable machine one is unable to see that it has had any particular effect at all on the improvement of fumigation. So far as the grower himself was concerned, and it is the grower for whom fumigation is supposed to be carried on, the fumigation was no different than if the machine had never been invented. The only improvement, or advance that it is possible to actually set forth in the case of the fumigation machine, was that it modified the method of gas generation. The advantage of the fumigation machine was for the generator of the fumigation crew rather than for the grower. There was perhaps also a less burning of tents. Machine generation gave results almost actually comparable with the pot method of fumigation, both in the way of scale kill as well as tree damage; the cost to the grower was the same. I believe it had the disadvantage of perhaps killing more trees than the pot method ever did, because of disposal of the residue in large volumes in one place. The cyanofumer frequently gave poor results at the end of the 'throw,' a disadvantage not present with pots. The one outstanding feature, and perhaps economy, was that the fumigator did not have to put as many small patches on his tents. The results of both Gray and Young were from a chemical standpoint and did not include orchard results against scale pests, which is a primary basis of fumigation."

of tents could scarcely last more than four or five years. The first fumigation machine was invented by Mr. William Dingle, who had eight working models of the machine for demonstrations in 1913 and was called the "Owl Fumigating Machine." [218]

A good description of this machine was published by George P. Gray [219] which we quote:

The construction of the machine is rather simple. It consists of a generating cylinder of about thirty or forty gallons capacity mounted on two wheels and provided with shafts, and may be moved about the field by one horse. Mounted directly over this main cylinder are two small supply tanks in one

FIG. 150.—In 1913 the fumigating machine made its appearance and was a step in advancing HCN fumigation in the citrus orchards of California. In this machine of iron, steel, and lead construction, the gas was generated in a steel drum and conducted into the tent by means of a large rubber hose. It was a return to the first idea of generating the gas outside the tent.

of which is contained the concentrated solution of cyanide. In the other is contained concentrated sulfuric acid. Each one of these supply tanks is connected by means of a three-way valve to a measuring cylinder or graduate. The valves are each operated by a lever and by adjusting the position of this lever, the solution flows from the supply tank into the graduate. A slight change in position stops the flow of liquid. By setting the lever in a third position, the liquid will flow from the graduate into the main generating cylinder. In practice, the proper amount of cyanide solution is measured off into its graduate and a corresponding amount of sulfuric acid is measured into its graduate. By throwing both levers into the proper position, the meas-

[218] Gray, Geo. P., *New fumigating machines*, Calif. State Commr. Hort., Mthly. Bul., vol. 4, pp. 68–80, figs. 15–17 (1915).
[219] *Op. cit.*, pp. 69–71.

ured cyanide and acid will flow simultaneously from their respective graduates through pipes into the main generating cylinder. Directly under the discharge pipes is a leaden bowl to effect a complete mixture of the cyanide and acid. The main generating cylinder is provided with a two-inch opening attached to which is a hose long enough to conduct the generated hydrocyanic acid gas into the fumigation tent. The generation of gas by this method is very rapid, requiring only a part of a second for a moderate-sized charge. A considerable amount of heat is produced by chemical action, so that after one or two charges, the whole apparatus becomes uncomfortably warm to the hand. The leaden bowl previously referred to in which the reaction takes place is mounted on a pivot and provided with an outside lever. After the generation of each charge, the residue is emptied into the bottom of the main cylinder. The supply tanks are constructed of iron and the upper part of the main cylinder is also of iron. To lessen corrosion, the lower third of the main cylinder is constructed of lead about one-half inch thickness. The measuring of the acid and cyanide is managed by means of levers which does away with the inconvenience of weighing and measuring by hand. The carrying of pots is also avoided. Provision is also made for the collection of the residue which is carried off from the field at intervals.

The advantages of such a machine were summarized by Gray [220] as follows:

The construction of the machines almost entirely prevents "spatter," which may be a factor in fruit and foliage injury and is certainly the most important cause of acid burning of tents.

The dose may be measured more accurately and rapidly in liquid form than by weighing the solid, thereby saving material and economizing time.

Convenient provision is made for the collection and removal from the orchard of the strongly acid residue, which is an undesirable addition to the soil and is also a menace to the tents.

It is believed that the maximum delivery of gas is obtained on account of the heat produced by the action of the acid upon the water and the chemical reaction.

The generation of the gas is very rapid and the tent is filled with the maximum concentration of the gas before leakage becomes an important factor.

The cost of operation is reduced, the machine saving one man's time.

The greatest advantage of this system is in the very material lengthening of the life of the tents. Acid burns in the tents are almost entirely eliminated.

The only serious disadvantage was the short life of the machines due to corrosion which was offset in a great measure by using metals which would resist the action of the chemicals.

The results in killing the scale insects in the orchards were satisfactory from the very beginning and fumigating machines became very popular. These machines, of which a number were made, were never sold outright to the orchardists but leased out for a definite period of time. The cyanofumer,[221]

[220] *Op. cit.*, pp. 72–73.

[221] Young, H. D., *The generation of hydrocyanic acid gas in fumigation by portable machines*, Calif. Agr. Expt. Sta., Circ. 139, 8 pp., 5 figs. (1915).

new machine, appearing in 1915 was fully described by H. D. Young,[222] a part of which we quote: "It consists essentially of two tanks, one above the other. In the lower tank is placed the sulfuric acid and water, in the upper one, the cyanide solution. By the action of a suitable pump, measured quantities of the cyanide solution are forced into the tank containing the acid and water, and the gas is generated almost instantly and discharges through the delivery hose with considerable force. The pump is graduated on the basis of a standard solution obtained by dissolving 200 pounds of pure sodium cyanide in 50 gallons of water. With a solution of any different strength it would of course give other amounts than those marked on the pump cylinder. The basic principle involved is that small successive quantities of cyanide solution are added to a large amount of acid and water until the acid is nearly exhausted. This constitutes such a radical departure from the accepted methods of fumigation that its accuracy has been widely questioned."

In a summary Young states the advantages of this machine as follows:

Greater accuracy of dosage, cleanliness, rapid generation so that a greater concentration of gas under the tent is obtained, and a lessening of tent burning. (This probably constitutes the greatest saving of the new methods.)

The Cyanofumer introduces an entirely different ratio in the dosage schedule, since successive quantities of sodium cyanide are added to a large amount of sulfuric acid.

The amounts of sulfuric acid, water and cyanide recommended for use, give a high and uniform production of gas under the proper conditions.

The best production of gas is obtained with a high temperature.

It is extremely important to keep the cyanide solution and tank scrupulously clean. Any dirt or small bits of wood may interrupt the pump and so make the charges irregular. Under normal conditions with clean solutions, the pump works with great regularity.

In order to gather and place before the citrus growers of southern California all the valuable data relative to hydrocyanic acid fumigation, C. W. Woodworth conducted at Pomona, California, August 9–13, 1915, a school of fumigation, the proceedings of which subsequently appeared in printed form.[223]

During this and the former period Woodworth made some theoretical studies to ascertain the basis for determining dosage tables and to allow for the important item of tent leakage.[224]

[222] *Op. cit.*, p. 3.

[223] *School of Fumigation* (Los Angeles, The Braun Corporation, 1915), 184 pp., 44 figs.

[224] *Leakage of fumigation tents*, Jour. Econ. Entom., vol. 4, pp. 376–380, pl. 15 (1911).

A new leakage gauge, Calif. Agr. Expt. Sta., Circ. 75, 15 pp., 8 figs. (1912).

Relative size in fumigation, Jour. Econ. Entom., vol. 8, pp. 302–304 (1915).

Theory of toxicity, *ibid.*, pp. 509–512 (1915).

R. S. Woglum summarized the general methods of fumigation in 1918 [225] which was a fitting ending for the fourth era.

Fifth Period, 1916–1927. Liquid hydrocyanic acid gas

The fifth and present period of fumigation began with the manufacture and use of liquid hydrocyanic acid gas [226] which soon replaced the expensive fumigating machines. To William Dingle, who first demonstrated the use of the liquid gas in 1916, also belongs the credit of this achievement. The liquid gas is applied beneath the tents by several types of machines of which the small hand atomizers are most generally used. Vaporizers of several types were also used as well as a machine known as an autofumer. In the last two types the gas was usually heated as it was being liberated under the tents. Although it requires careful manipulation, the liquid gas has made it possible to substitute light, portable apparatus for the bulky and heavy equipment necessary for both the pot and machine methods.

The liquid gas, although of poor quality in 1916, was manufactured as a high-grade product in 1919 and with the development of safe containers and efficient applicators, has been accepted for use in the orchards, warehouse and elsewhere. A splendid account of the properties and fumigation with liquid hydrocyanic acid gas was given in 1919 by H. J. Quayle and George P. Gray.[227]

The whole subject of pot, machine, and liquid gas fumigation are again summed up by Woglum [228] in his final bulletin on this subject. He concludes with the following summaries:

> Trees should be measured, not guessed at, and dosed according to standard schedule.
>
> A careful, experienced foreman is the keystone to safe, effective fumigation.

[225] *Fumigation of citrus trees*, U. S. Dept. Agr., Farmers' Bul. 923, 30 pp., 17 figs. (1918).

[226] Concerning this important discovery Woglum writes: "The use of liquid hydrocyanide acid was indeed revolutionary. While machine generation differed scarcely at all from pot generation in the way of tree effect and scale kill, the liquid method differs radically in numerous respects. Whereas, I consider the standardization of fumigation as the outstanding point of greatest value to the citrus grower, the liquid method must be viewed as second in importance to the standardization. The diffusion of gas from the cold liquid differs from the pot or machine generated gas, although vaporized gas is practically the same. There is no burning of tents, the delivery of gas is far more uniform than with the old methods, the trees can be fumigated under more adverse conditions with safety, and furthermore, the cost under the liquid method, even in spite of the more expensive labor, is practically the same today as it was twenty years ago."

[227] Calif. Agr. Expt. Sta., *Bul. 308*, pp. 393–428, 4 figs. (1919).

[228] Woglum, R. S., *Fumigation of citrus trees for control of insect pests*, U. S. Dept. Agr. Farmers' Bul. 1321, 58 pp., 33 figs. (1923).

Fig. 151.—An autofumer operating in an orange orchard in California. In this and other vaporizing fumigating machines, the liquid HCN is heated before being liberated into the tents. (Photograph furnished by the California Cyanide Company, 1925.)

Use heavy dosages. Start with an 85 per cent schedule, if possible. Raise to 100 per cent as soon as the trees will stand the heavier dosage.

Fumigation during even a moderate wind tends toward poor results and is advised against.

It is poor policy to fumigate orchards heavy in cover crop.

All equipment should be kept in good repair.

Tents should be centered on trees, kicked in to hang perpendicular from the outer limbs, and the edges touch the ground all around.

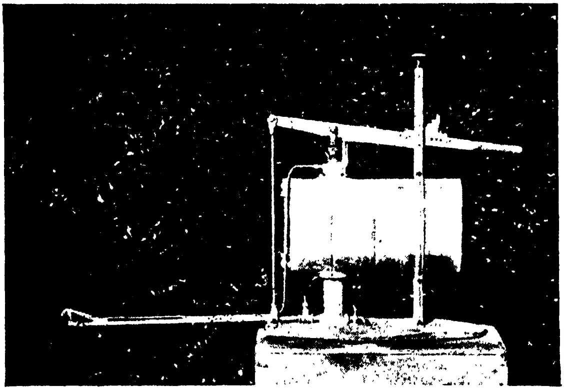

FIG. 152.—A hand atomizer used in vaporizing liquid HCN under the tents. Cold gas was used. (Photograph furnished by H. J. Quayle, 1926.)

It is well to keep records of individual tree dosage, temperature, humidity, and time of start and finish.

Fumigating machine

Test the fumigating machine for accuracy two or three times a week.

Stir the cyanide solution in the solution tank before using.

Before fumigating a row, generate 2-ounce charges until the machine is filled with gas.

Cyanide solution will crystallize at temperatures around 40° F.

The same dosage schedule is used for the fumigating machine as for pots.

For liquid gas a slightly different schedule is used in which the dosage for large trees is somewhat increased.

Liquid hydrocyanic acid

Liquid hydrocyanic acid is inflammable. Keep open flames at a distance from drums or applicators.

Inspect and test applicators for accuracy every day before starting work.

Direct the nozzles of applicators away from the trunks of small trees to avoid injury.

The nozzles of applicators should not be placed among weeds or cover crop, and should be within the foliage fringe of the tree.

Results from atomized liquid gas appear to be most satisfactory at warm temperatures. Preferably it should be used at temperatures above 50° F.

Vaporized liquid gas gives a better diffusion within the tent than when atomized through a nozzle.

Eighteen cubic centimeters of high purity liquid gas is equivalent to 1 ounce of sodium cyanide for scale kill under field conditions.

Injury

Avoid fumigating trees sprayed with Bordeaux mixture, or painted with Bordeaux paste high above the trunks, within 6 to 10 months after application. If done at a shorter interval, fumigate only at low humidity and with dry tents.

Fumigation with pots or fumigating machine should be stopped at 36° F. on damp nights; and on dry nights, when frost warnings indicate that the temperature is likely to fall to freezing or below, complete safety demands stopping at 43° to 45° F.

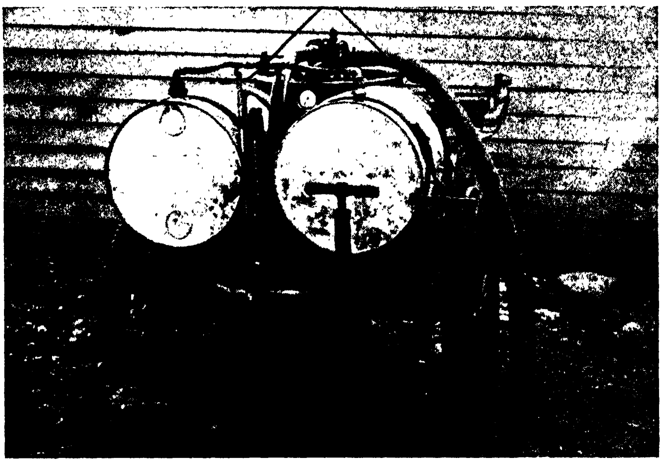

FIG. 153.—A modern liquid HCN vaporizer used in orchard fumigation in California in 1929.

Fumigation with wet tents often is the cause of severe injury. Work should be stopped when tents become wet.

Sunshine is one of the most harmful agents to plants in connection with fumigation. It exerts an influence both during and after the treatment. Safe sunlight fumigation requires a proper knowledge of dosage, exposure, and temperature influences. Without this knowledge daylight fumigation should not be attempted.

In the coastwise districts it is generally unsafe to fumigate above 75° F. In hot interior districts, where the trees harden in summer, work appears to be carried on with safety even as high as 85° F.

Sulfuric acid will burn canvas. Care should be exercised, therefore, to avoid the residue from fumigating machine or pots coming into contact with the tents.

Fumigation during periods of desert or "electric" winds sometimes produces severe fruit injury.

Trees in bloom can be fumigated with safety with moderate dosages.

Fumigation should precede rather than follow an irrigation.

Hydrocyanic acid gas is one of the most deadly gases known. Particular care should be exercised in handling liquid gas. Two men should always be present when filling the machine. Drums should not stand exposed to hot sunshine. Each man should be furnished with a small bottle of ammonia for use in case one of the crew is overcome. At least two men on each crew should be familiar with the prone pressure method of resuscitation.

Before concluding this discussion of orchard fumigation attention should also be called to the use of calcium cyanide dust for this purpose. These investigations were originated by H. J. Quayle [229] in August and September, 1922, and continued by him for several years. The method consists simply in blowing the finely powdered dust under the tented trees. Hand and power dust applicators for measuring and distributing the dust under the tents were perfected by 1926.[230] At this writing the method is still in the investigational stages of development. However, calcium cyanide dust has received wide uses in the control of rodents,[231] ants,[232] termites,[233] wireworms [234] and other soil inhabitants, as well as for bugs,[235] leafhoppers,[236] the pear psylla,[237] and many other plant-infesting insects.

[229] *Calcium cyanide dust as an insecticide*, Jour. Econ. Entom., vol. 16, pp. 327-328 (1923).

Calif. College of Agr. and Agr. Expt. Sta., *Rept., 1922-1923*, pp. 99-100 (1923).

[230] Quayle, H. J., *New material for citrus fumigation*, Calif. Citrograph, p. 296 (June, 1926).

[231] Wade, Otis, *The effectiveness of calcium cyanide in the extermination of the black tail prairie dog*, Cynomys ludovicianus (*Ord.*), Jour. Econ. Entom., vol. 17, pp. 339-342 (1924).

[232] Manter, J. A., *A preliminary report on the use of calcium cyanide for the mound building ant*, Formica exsectoides, *ibid.*, vol. 18, pp. 348-350 (1925).

[233] Brittain, W. H., *Experiments in the control of scavenger termites in India and Ceylon by means of calcium cyanide*, Am. Cyanamid Co., Research, pp. 4-115 to 4-124 (1926).

[234] Campbell, R. E., *Preliminary report on the use of calcium cyanide dust as a soil fumigant for wireworms*, Jour. Econ. Entom. 17, pp. 562-567 (1924).

The concentration of wireworms by baits before soil fumigation with calcium cyanide, *ibid.*, vol. 19, pp. 636-642 (1926).

Horsfall, J. L., and Thomas, C. A., *A preliminary report on the control of wireworms and truck crops*, *ibid.*, vol. 19, pp. 181-185 (1926).

[235] Flint, W. P., and Balduf, W. V., *Calcium cyanide for chinch-bug control*, Ill. Agr. Expt. Sta., Bul. 249, pp. 73-84, 5 figs. (1924).

Haseman, L., and Bromley, S. W., *Controlling chinch bugs in Missouri with calcium cyanide*, Jour. Econ. Entom., vol. 17, pp. 324-329 (1924).

[236] Knight, H., and Greer, F. C., *Grape leafhopper control with calcium cyanide dust*, Calif. College of Agr. and Agr. Expt. Sta., Rept. 1922-1923, p. 100 (1923).

Quayle, H. J., *Calcium cyanide dust for control of the grape leafhopper*, Jour. Econ. Entom., vol. 17, p. 668 (1924).

[237] Mundinger, F. G., *Investigations on the control of pear psylla*, N. Y. State Agr. Expt. Sta., Bul. 529, 36 pp., 19 tab. (1925).

Vacuum Fumigation[238]

Vacuum fumigation for the control of insects in relation to agriculture appears to have first been used by D. B. Mackie when entomologist of the Philippine Islands in 1914. Concerning this he writes under date of September 11, 1929:

> My article was published as a circular issued on March 2, 1915, although the work was completed the former year.
>
> The utilization of a vacuum for fumigation purposes for pest control has apparently been known for some time. I find in the records of the patent

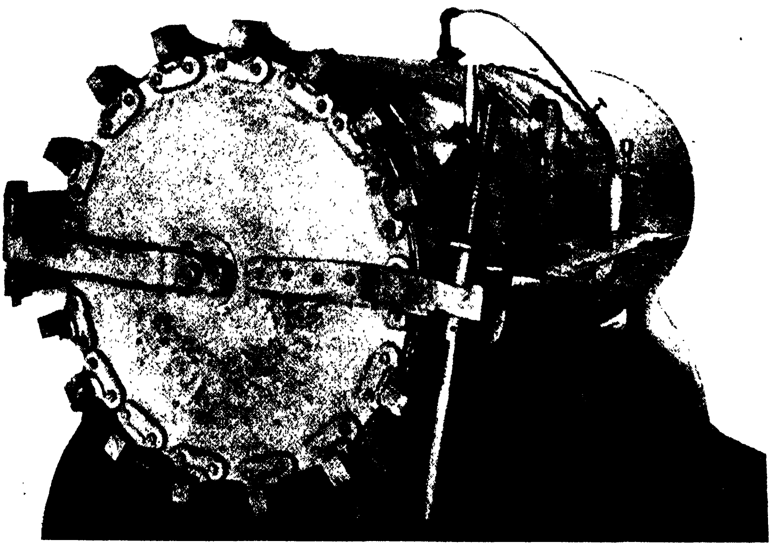

Fig. 154.—The vacuum fumigating machine originated in the Philippine Islands for fumigating cigars by D. B. Mackie in 1917. It was one of the very first vacuum fumigators. (After D. B. Mackie, 1917.)

> office that in France as far back as 1892 there is a record of utilizing vacuum in connection with treatment of products to destroy insect life. From my knowledge of the subject, however, I would say that the treatment recommended was not feasible, as the gases recommended were sulfur dioxide

[238] Cole, F. J., *The binomics of grain weevils*, Jour. Econ. Biol., vol. 1, pp. 63–71 (1905–1906).

Sasscer, E. R., *Inspection facilities in the District of Columbia*, Jour. Econ. Entom., vol. 9, pp. 222–223, pl. 13 (1916).

Effect of hydrocyanic acid gas under vacuum conditions on subterranean larvæ, Jour. Agr. Research, vol. 15, pp. 133–136 (1918).

Maskew, F., *How the Quarantine Division protects the cotton producer*, Calif. State Com. Hort., Mthly. Bul., vol. 5, pp. 311–316, figs. 101, 102 (1916).

Back, E. A., and Cotton, R. T., *Common pests destructive to household goods in storage*, Proc. Am. Warehousemen's Assoc., vol. 34, pp. 185–188, figs. (1924).

and chlorine. These could not help but be harmful from the standpoint of injury to the product and also to the apparatus used; that is, the pumps. Further substantiating this belief is the fact that I have prepared practically all of the work published by the French Department of Agriculture on vacuum fumigation.

My first work with the utilization of a combination of gases was in an endeavor to develop an irrespirable mixture in the hope that it would be more toxic. The great stimulus, however, to this combination arose from the fact that carbon disulfide was found to be very unstable, and a galvanic spark was generated under certain conditions where the pressure was raised rapidly. This created an explosion hazard that had to be remedied and we were able to do it with the addition of CO_2. I find, however, that there is a record of a French patent where this combination of gases was used in 1918. They claim, however, that the carbon dioxide produces anæsthesia and the insect is unable to set himself against the vacuum, to use their language. However, we have no record of commercial development along this line.

The use of nitrogen in connection with carbon disulfide was developed by myself in an effort to get away from the freezing which took place in the cylinders of carbon disulfide. In this connection, such experiments have shown that nitrogen has the same blanketing value as carbon dioxide in preventing explosion under conditions which pertain during fumigation procedure. The latest development is in connection with ethylene oxide in combination with carbon dioxide. From the present appearance, it looks like this gas will enable the extension of vacuum fumigation to new fields where it is at present curtailed due to the fact that the carbon disulfide gas is solvent and leaves very noticeable residue in products which contain a high oil content.

His work in the Philippines was aimed to control the cigarette beetle, *Lasioderma serricorne* (Fabr.), infesting cigars. In a summary of the work of the pest control section for the year 1916 [239] a picture of the machine (Fig. 154) is presented and this further information given:

As indicated in the last report manufacturers have been unreasonably prejudiced against any treatment of their product in which any chemical was utilized. This attitude has greatly hampered the application of control measures. However, by persistent study, it has been possible to devise an apparatus by means of which tobacco products could be treated in such a manner as to kill all beetles, regardless of whether they were in the egg, grub, pupal or adult stage.

The process in question consists of heating the tobacco to a certain degree after which the air is pumped out till a 28-inch vacuum is registered by the vacuometer. The material being heated higher than the vapor tension point of water under this pressure, this causes the water content of all bodies comprehended therein to change to a gaseous form, and thus all insects are killed.

[239] Mackie, D. B., *Philippine Agr. Rev.*, vol. 10, pp. 128–145, pl. 14 (1917).

What this means to the tobacco trade can be understood from the following: A tobacco manufacturer who equipped his factory with one of the machines brought out by this office in 1914 for use of vacuum with carbon disulfide, reports that he has been able to secure one order for 25,000,000 cigars simply by reason of the fact that he could guarantee his product free from the beetle. When it is understood that every million cigars pay an internal revenue tax of $3,000, the tax collected from one such order amounts to $75,000, or

FIG. 155.—A vacuum fumigation plant with two vacuums.

more than twice the annual amount available to run the entire pest control project for one year, inclusive of the $25,000 available for contributions and gratuities, the importance of this work can be realized.

While investigations relative to the treatment with heat and vacuum are completed, 14,000,000 cigars having been processed, it has been agreed that manufacturers should wait six months in order to hear from shipments made to the United States. One hundred thousand cigars were processed per day in order to demonstrate that the process was commercially possible.

Prior to the publication of Mackie's work, E. R. Sasscer, Chief Inspector, Federal Horticultural Board, and Lou A. Hawkins, Plant Physiologist, Plant Physiological and Fermentation Investigations, both of the U. S. Department of Agriculture, published a bulletin on the treatment of seed by vacuum fumigation, February 27, 1915.[240] Their work was entirely independent of that of Mackie although their apparatus was much the same. Hydrocyanic acid gas was used. They experimented with a number of insects and the bulb mite and secured satisfactory results, without injury to the seeds.

The use of a more elaborate apparatus and gases were ap-

[240] *A method of fumigating seed*, U. S. Dept. Agr., Bul. 186 (February 27, 1915).

parently first employed by E. R. Sasscer [241] in connection with the fumigation of foreign plant products passing through the hands of the Federal Horticultural Board in 1916. The apparatus consisted of a wooden fumigating chamber or retort, an auxiliary chamber or generator for the generation of the gas and an air pump. The air was exhausted in the chamber to the gauge reading of 26 inches after which the gas was admitted, hydrocyanic acid gas being used in this case.

F. Maskew illustrated and explained the workings of a very much improved steel vacuum fumigator used at the Port of San Francisco in 1916 for the fumigation of all foreign cotton entering the United States through that port. The method of procedure of this large commercial plant was as follows: [242]

> When the charge of cotton is in the chamber the doors are closed and clamped and the air is exhausted until the gauge registers 25 inches. At this stage the gas is generated by introducing into the generator the chemicals in the following order: water, acid and cyanide in solution. The cyanide solution is run into the generator at a rate that will require from 8 to 10 minutes for all of the solution to be introduced. At the expiration of 15 minutes air is permitted to pass through the generator for 5 minutes to wash out all gas that may be in the generator and then the valve between the generator and the chamber is closed. At this stage the air is admitted into the chamber until the vacuum gauge on the same falls to 5 inches. The cotton is held in the presence of the gas for 1 hour and 25 minutes additional, making the complete exposure 1 hour and 45 minutes. The formula for fumigating cotton is 6 ounces avoirdupois sodium cyanide, 6 fluid ounces of sulfuric acid and 6 fluid ounces of water for each 100 cubic feet of chamber space. For all grades of cotton waste as specified the formula is 9 ounces avoirdupois of sodium cyanide to each 100 cubic feet of chamber space. All imported cotton, even to broker's samples, goes through this drastic disinfection process before being permitted to leave the port of entry for distribution in the United States.

In 1920 D. B. Mackie, State Department of Agriculture, began accurate investigations of vacuum fumigation to determine its various uses in connection with the control of insect pests affecting nursery stock, dried fruits, and various stored products in California. A small fumigator was set up in the old insectary building in Sacramento and work was also conducted at large plants in various parts of the state.[243] Carbon disulfide and HCN were used as

[241] *Jour. Econ. Entom.*, vol. 9, pp. 222–223, pl. 13 (1916).
[242] Maskew, F., *op. cit.*, p. 314.
[243] Mackie, D. B., *The application of vacuum fumigation to fresh and packed dates*, Calif. State Dept. Agr., Mthly. Bul., vol. 9, pp. 321–324, figs. 87–88 (1920).

fumigants. As a result of his work a vacuum fumigator was installed in the Los Angeles plant of the California Walnut Growers' Association in 1921 for the treatment of sacks likely to carry the larvæ of the codling moth. Carbon disulfide was used and 38,000 sacks treated that season.[244] The successful results obtained in treating nursery stock, dried fruits, grapevines, nuts, potatoes, and apparatus by this method of fumigation were presented in detail at the Third Convention of the Western Plant Quarantine Board held in Victoria, British Columbia, June 8, 1921.[245] Plans for sterilizers were prepared for distribution to interested parties throughout the state and much headway was made in this direction.

Additional work on the treatment of citrus nursery stock was done in Ventura County in the winter of 1921–1922 in connection with County Horticultural Commissioner A. H. Call, and Inspector C. R. Tower,[246] which cleared up a number of debated points as to time of exposure, injury to the trees, etc., proving in general, the practicability of treating citrus nursery stock by this method. The work was continued also at plants at Los Angeles and Santa Ana. The results as published in 1927 [247] were expressed as follows:

> In the ornamental field a wide range of plants has been successfully treated. It seems established that vacuum fumigation with high vacua (27") and heavy dosage (25 cc. HCN) can be accomplished with many species if the plants are cured slowly until all new growth is adequately hardened. Several hundred plants, involving over fifty species infested with citrophilus mealybug, were fumigated at our regular schedule in May. These were thoroughly inspected at destination and neither live mealybugs nor treatment injury was noted.
>
> In other branches of this work the gases used in commercial practice have been carbon disulfide and carbon dioxide in combination. The employment of this gas combination reached its most extended use in treating new potatoes to meet quarantine requirements of Oregon, Washington, and Idaho, pertaining to potato tuber moth. This treatment problem, an annual one, has caused us considerable concern in view of the fact that a rainy spring renders potatoes very sensitive to fumigation. In this connection extensive studies show that even though potatoes may carry larvæ of potato tuber moth, it does not pupate in potatoes underground. This finding simplifies our problem since the larval

[244] *Ibid.*, vol. 10, p. 575 (1921).

[245] Mackie, D. B., *Nursery stock quarantine*, Proc. 3d Conv. Western Plant Quar. Bd., Calif. State Dept. Agr., Mthly. Bul., vol. 10, pp. 271–277 (1921); *Mthly. Bul.*, vol. 10, pp. 576–580 (1921).

[246] Mackie, D. B., *Vacuum fumigation of citrus nursery stock in Ventura County*, *ibid.*, vol. 11, pp. 726–735, figs. 172–176 (1922).

Also see Woglum, R. S., *Vacuum fumigation of citrus nursery stock*, Calif. Citrograph, vol. 9, pp. 316–317, 2 figs. (June, 1924).

[247] *Ibid.*, vol. 15, p. 126 (1927).

stage of this species yields to a comparatively low dosage of CS_2 and CO_2, while the pupæ are more resistant. With the resistant pupa hazard removed, potatoes can now be treated without so closely approaching the danger line of commodity injury.

In the same year experiments with vacuum fumigation showed that bulbs infested with the lesser bulb fly, *Eumerus strigatus* Fallén, could be successfully treated and the insect killed by using carbon disulfide "at the rate of 2 pounds per 100 cubic feet for a period of one hour, with no deleterious results." [248]

R. I. Smith performed experiments on the larvæ of the brown-tail moth and the European corn borer at Melrose Highlands, Mass., in February, March, and April, 1921, under fairly low temperatures. The former were killed at 39° F. to 50° F., whereas those of the latter were taken from a temperature of 40° to 45° F. and fumigated at 65° to 70° F. and were not killed.[249]

E. A. Back and R. T. Cotton published a paper on the use of the vacuum for insect control in 1925 [250] in which experiments were given relative to the control of insects affecting stored product insects. They also gave a brief history and a short bibliography of vacuum fumigation.

In August, 1928, Charles Keane, editor of the Monthly Bulletin, California State Department of Agriculture,[251] summed up the progress of vacuum fumigation in these words:

> Judging from the number and character of communications received asking about California's vacuum fumigation method of controlling insect pests, this state is now the clearing house for information on this subject, not only for the United States but for nearly all parts of the world. The method, perfected largely through the efforts of D. B. Mackie of this department, has proved so exceptionally satisfactory that fumigators are now being installed in many of the fruit growing countries of the world.
>
> One of the first foreign entomologists to recognize the value of vacuum fumigation was Paul Marchal, entomologist of the Republic of France. His assistant, P. Vassierre, is attending the International Entomological Congress at Ithaca, New York, this month where he will further discuss with Mackie the latest developments in vacuum fumigation prior to the installation of new plants in that country.
>
> Spain and Italy have asked for information while Morocco, under the guidance of P. Regnier, is considering the immediate installation of a series of plants.

[248] Mackie, D. B., *Note on the lesser bulb or lunate fly*, *ibid.*, vol. 11, p. 759 (1922).
[249] *Jour. Econ. Entom.*, vol. 16, pp. 317–321 (1923).
[250] *Jour. Agr. Research*, vol. 31, pp. 1035–1041 (1925).
[251] Vol. 17, p. 437 (1928).

That the farmers in the African colonies are awake to the importance of protecting their shipments against pest infestation is evidenced by the fact that the Union of South Africa, Portuguese East Africa and Kenya Colony have all made investigations and established one or more fumigation plants.

The largest plant in the world has been established at Guadalajara, Mexico, and preparations are now in progress for the establishment of three additional

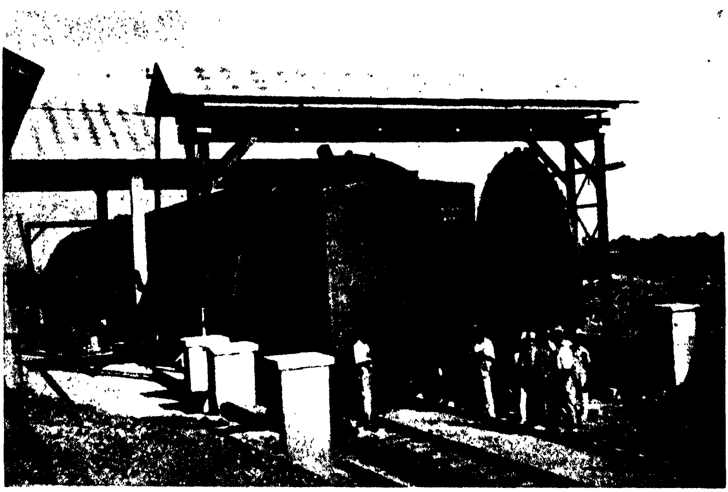

FIG. 156.—The first car entering the huge vacuum fumigator at Guadalajara, Mexico. (Photograph furnished by D. B. Mackie, 1929.)

plants at Matamoros, Torreon and Juarez. The Guadalajara plant will take three box cars at one load.[252]

Requests for information have been received from India, Germany, Russia, Canada and New Zealand, and from Australia, Hawaii and the Philippine Islands, the three latter countries having already installed plants.

During the past month requests were received from the governments of Cuba and Chile for assistance in settling the problem of pest control against Chilean potatoes on account of the presence of three species of potato weevils in that country. Cuba is a strong advocate of vacuum fumigation, having originally taken up the matter for control of storage pests of tobacco. The appeal from the joint governments is the first instance where the department has been approached by two countries for assistance in settling a pest control question.

[252] Estados Unidos Mexicanos, Sec. Agr. Fomento, *Bol. Mensual*, 2, tomo 2, nos. 8–9, pp. 451–460, 7 figs. (Sept., 1928).

CHAPTER VIII

ENTOMOLOGICAL LEGISLATION

California originated the practice of using legal means of preventing the introduction and distribution of insect pests within its confines. Certain of the common insects such as the granary and rice weevils, cabbage aphis, and black scale were introduced at a very early date and were taken as a matter of course, but the discovery of the cottony cushion scale in the citrus orchards of southern California in 1872 and the subsequent damages occasioned by it, and the appearance of the grape phylloxera and the codling moth in northern California in 1874 and the San José scale in 1879 were viewed with much alarm. Some of the leading horticulturists realized that already too many serious insects had gained a firm foothold in the state and that something should be done to stop the introduction of other foreign pests. Prior to, and during the Middle Ages, insects had been the objects of litigation of both the Church and the State, but so far they had never been the causes of legal procedure in this country.

Board of State Viticultural Commissioners of California

A Board of State Viticultural Commissioners consisting of nine members to be appointed by the governor, and a secretary elected by the board, was created by an act (Chapter 62), for the promotion of the viticultural industries of the state, approved by Governor George C. Perkins, April 15, 1880. This board was created to promote the general viticultural interests of the state, it being a common belief in those days that California was destined to be chiefly a great grape growing and wine making region. In order to deal with the grape phylloxera and the codling moth in particular, and other pests in general, the duties and powers of this board were enlarged and the appointment of certain officers was authorized by an act (Chapter 51), of the legislature approved March 4, 1881. In other words the Board of State Viticultural Commissioners, in addition to their original powers, in respect to diseases of grape-

vines and vine pests, constituted a Board of Health, and in addition to laboratory work were directed to "cause practical experiments to be made to determine or demonstrate the utility of known and new remedies against such diseases and pests."

The board was authorized to elect of their own number or appoint from without their number two competent officers: a Chief Executive Viticultural and Health Officer and a Chief Executive Horticultural and Health Officer. The terms of office were subject to the will of the board as were also the salaries, which, however, were not to exceed one hundred and fifty dollars per month, each, for services and not to exceed five hundred dollars per annum for traveling expenses. In the discharge of their respective duties each of the officers was empowered, with the approval of the board, to:

Prevent the spread of diseases and pests, by declaring and enforcing rules and regulations in the nature of quarantine.

Prohibit the importation into the state, and the distribution and disposal within the state, of all vines and horticultural plants, cuttings, débris from orchards and vineyards, empty fruit boxes or other material on or by which the contagion may be introduced into the state or transported from place to place within the state.

Declare and enforce regulations for the disinfection of such materials enumerated above and other suspected materials dangerous to vineyards and orchards, while in transit, or about to be distributed, or transported into, or within the state.

Classify the vineyards and orchards into regions according to the degree of health or diseases prevailing therein and adopting rules and regulations as may become necessary and expedient for the preservation of the vineyards and orchards.

Appoint inspectors in any of the regions of the state, whose duties shall be to report conditions relative to diseases and pests, and violations of rules and regulations, to certify to the proper disinfection of plant materials, fruit boxes and other materials liable to carry pests and diseases, and to destroy all prohibited articles discovered in transit.

Chas. A. Wetmore, vice-president of the Board of State Viticultural Commissioners, was appointed Chief Executive Viticultural and Health Officer. On November 16, 1881, he drew up the following viticultural quarantine rules and regulations:

RULE 1. All cuttings of grapevines made in this state for sale, gift, or distribution outside of the vineyard or vineyards where the same were grown, and intended for new plantations, shall be made solely of the wood of the preceding year's growth; all older wood to be carefully and thoroughly removed before leaving the vineyard where made, and to be immediately destroyed by fire, if removed from such cuttings, wherever seized by any duly authorized inspector for any invasion or infraction of this rule. The reason for this rule is, that the winter egg of the *Phylloxera vastatrix* is, according to the best authorities, found only on the old wood.

RULE 2. All cuttings of grapevines, and rooted grapevines, imported from any region or country outside of this state, intended for sale, gift, or distribution for plantation in this state, shall be disinfected at the place of first consignment within this state before being further distributed or planted, the method of disinfection to be at the option of the owner or agent in charge of the said cuttings or vines, according to any one of the following methods, viz.:

First—Dissolve sulfo-carbonate of potash in cold water; proportions, ten pounds of sulfo-carbonate to one hundred gallons of water; immerse cuttings and rooted vines fifteen minutes.

Second—Dissolve Little's soluble phenyle by pouring upon it cold water in the proportion of fifty gallons of water to one gallon of the phenyle; immerse cuttings and rooted vines ten minutes.

Third—Take two parts heavy oil of coal tar, two parts water, and one part carbonate of potash or carbonate of soda; put in a covered vessel and heat gently to boiling point for one hour; replace water lost by evaporation; pour into suitable vessels and agitate violently; dilute with fifty parts of cold water; immerse cuttings and rooted vines ten minutes.

Fourth—Dissolve carbolic acid crystals in water, in proportion to one pound of acid to twenty gallons of water; immerse cuttings and rooted vines ten minutes.

Fifth—Dissolve sulfide of potash in the proportion of one pound to twenty gallons of water; immerse cuttings and rooted vines twenty minutes.

Sixth—Dilute one part of "liver of lime" in twenty parts of water; immerse cuttings and rooted vines ten minutes. (N. B.—To make "liver of lime," take one pound of quicklime, one pound sulfur, one gallon water; mix; boil over quick fire to one half of volume; agitate before using; dilute with twenty parts of water to one part of "liver of lime.")

Any other efficacious method may be used, provided due notice is given to this office and the same be approved.

INSPECTORS

For the convenience and protection of all interested parties throughout the state, there will be appointed local resident inspectors, as provided for by law, for each section or region where vine growers desire the same, and upon the application of any three such neighboring growers, or parties intending during the coming season to plant vines, such application to be addressed to this office, and to be accompanied, whenever practicable, with nominations of suitable persons for the office of inspector. The other inspectors required by law will be appointed by this office.

RECOMMENDATIONS FOR THE FURTHER PROTECTION OF VINEYARDS

All persons planting new vineyards within the state are advised and strongly urged to consider all roots and cuttings suspected, regardless of origin, and to thoroughly disinfect them, thereby accomplishing the destruction of all possible germs of insect nests upon them, as well as also those of fungoid disease, which are becoming dangerous in all parts of the country.

CERTIFICATES

For the further convenience of vine growers, certificates shall be issued by any inspector residing near the vineyard of the applicant, or the person in charge of cuttings or rooted vines, setting forth that the provisions of Rule Two have been complied with, and shall be entitled to charge in each case not exceeding fifty cents for such certificate made out in duplicate, one certificate being sufficient to cover any quantity of cuttings or rooted vines in the possession of the applicant that may be satisfactorily shown to the said inspector to have been disinfected. Certificates of disinfection shall likewise be given any applicant who desires the same, and who shall satisfactorily show to the inspector that cuttings and rooted vines, other than such as are required to be disinfected by Rule Two, have been properly disinfected in accordance with the recommendations of this office.

INFECTED WRAPPINGS, ETC.

RULE 3. All packages and the packing materials coming into the state with imported cuttings and vines (referred to in Rule Two) shall be disinfected at the time of disinfecting the contents thereof, by immersing in or washing with any of the solutions named in Rule Two, provided that the strength of the same, in case of mere washing, shall be increased by the reduction of the water in the same to one fourth the relative proportions named. If not disinfected, such packages and packing materials shall be destroyed by fire.

PENALTIES

All infractions or evasions of these rules will be punishable according to law.

To facilitate the carrying out of the work of that portion of the act relating to horticulture, the State Board of Viticultural Commissioners, on April 5, 1881, passed a resolution organizing an Advisory Board of Horticulture.[1] This board as finally constituted was as follows:

CHARLES H. DWINELLE, President

Commissioner for the State at Large

W. W. Smith.................... Commissioner for the Napa District.
M. T. Brewer.............. Commissioner for the Sacramento District.
W. B. West................ Commissioner for the San Joaquin District.
Felix Gillet.................. Commissioner for the El Dorado District.
Albert S. White............ Commissioner for the Los Angeles District.

[1] Bd. of State. Hort. Commrs., *First Rept.*, pp. 4, 41–51 (1882).

S. F. Chapin.............Commissioner for the San Francisco District.
A. Cadwell....................Commissioner for the Sonoma District.
Matthew Cooke................Commissioner for the State at Large.
E. J. Wickson..................Commissioner for the State at Large.
Ellwood Cooper.................Commissioner for the State at Large.
JOHN H. WHEELER, Secretary,
MATTHEW COOKE, Chief Executive Horticultural and Health Officer.

Matthew Cooke was appointed Chief Executive Horticultural and Health Officer and on November 12, 1881, drew up the following quarantine rules and regulations for the protection of fruit and fruit trees:

1. All tree or plant cuttings, grafts or scions, plants or trees of any kind, infested by any insect or insects, or the germs thereof, namely, their eggs, larvæ, or pupæ, that are known to be injurious to fruit trees, and liable to spread contagion; or any tree or plant cuttings, grafts, scions, plants, or trees of any kind, grown or planted in any county or district within the State of California, in which trees or plants, in orchards, nurseries, or places, are known to be infested by any insect or insects, or the germs thereof, namely, their eggs, larvæ, or pupæ, known to be injurious to fruit or fruit trees, and liable to spread contagion, are hereby required to be disinfected before removal for distribution or transportation from any orchard, nursery, or place where said tree or plant, cuttings, grafts or scions, plants, or trees of any kind are grown, or offered for sale or gift, as hereinafter provided.

2. All tree or plant cuttings, grafts or scions, plants, or trees of any kind, imported or brought into this state from any foreign country, or from any of the United States or Territories, are hereby required to be disinfected immediately after their arrival in this state, and before being offered for sale or removed for distribution or transportation, as hereinafter described; provided, that if on examination of any such importations by a local resident inspector or the Chief Executive Horticultural Officer, a bill of health is certified to by such examining officer, then disinfection will be unnecessary.

3. Fruit of any kind, infested by any species of scale insect or scale insects, or the germs thereof, namely, their eggs, larvæ, or pupæ, known to be injurious to fruit and fruit trees, and liable to spread contagion, is hereby required to be disinfected, as hereinafter provided, before removal off the premises where grown, for the purpose of sale, gift, distribution, or transportation.

4. Fruit of any kind, infested by any insect, or the germs thereof, namely, their eggs, larvæ, or pupæ, known to be injurious to fruit and fruit trees, and liable to spread contagion, imported or brought into this state from any foreign country, or from any of the United States or Territories, are hereby prohibited from being offered for sale, gift, distribution, or transportation.

5. Fruit of any kind, infested by the insect known as codling moth, or its larvæ or pupæ, is hereby prohibited from being kept in bulk, or in packages or boxes of any kind, in any orchard, storeroom, salesroom, or place, or being dried for food, or any other purposes, or being removed for sale, gift, distribution, or transportation.

6. Fruit boxes, packages, or baskets used for shipping fruit to any destination, are hereby required to be disinfected, as hereinafter provided, previous to their being returned to any orchard, storeroom, salesroom, or place to be used for storage, shipping, or any other purpose.

7. Transportable material of any kind, infested by any insect or insects, or the germs thereof, namely, their eggs, larvæ, or pupæ, known to be injurious to fruit or fruit trees, and liable to spread contagion, is hereby prohibited from being offered for sale, gift, distribution, or transportation.

8. Tree or plant cuttings, grafts, scions, plants, or trees of any kind, may be disinfected by dipping in a solution composed of not less than one pound (1 lb.) of commercial concentrated lye to each and every two (2) gallons of water used as such disinfectant, or in any other manner satisfactory to the Chief Executive Horticultural and Health Officer.

9. Empty fruit boxes, packages, or baskets, may be disinfected by dipping in boiling water, and allowed to remain in said boiling water not less than two minutes; said boiling water used as such disinfectant to contain, in solution, not less than one pound (1 lb.) of concentrated potash, or three fourths ($\frac{3}{4}$) of one pound (1 lb.) of concentrated lye, to each and every twenty gallons of water, or in any other manner satisfactory to the Chief Executive Horticultural and Health Officer.

10. Fruit on deciduous and citrus trees infested by any species of scale insect or scale insects, or the germs thereof, namely, their eggs, larvæ, or pupæ, may be disinfected before removal from the tree, or from the premises where grown, by washing or thoroughly spraying said fruit with a solution composed of one pound (1 lb.) of whale oil soap and one fourth of one pound of flowers of sulfur to each and every one and one quarter ($1\frac{1}{4}$) gallons of water used as such disinfectant, or in any other manner satisfactory to the Chief Executive Horticultural and Health Officer.

11. Owners of fruit of any kind grown in any orchard, nursery, or place in which trees or plants are known to be infested with an insect or insects, or the germs thereof, namely, their eggs, larvæ, or pupæ, known to be injurious to fruit or fruit trees, and liable to spread contagion, and all persons in possession thereof or offering for sale, gift, distribution, or transportation, are hereby required to procure a certificate of disinfection before removal for sale, gift, distribution, or transportation.

12. Any tree or plant cuttings, grafts, scions, plants, or trees of any kind, empty fruit boxes, fruit packages, or fruit baskets, or transferable material of any kind, offered for sale, gift, distribution, or transportation, in violation of the quarantine rules and regulations for the protection of fruit and fruit trees, approved by the Board of State Viticultural Commissioners, may be seized by the Chief Executive Horticultural and Health Officer, or by any of the local resident inspectors appointed by him; said seizure to be the taking possession thereof, and holding for disinfection, or for an order of condemnation by a court of competent jurisdiction.

13. Any person violating the above quarantine rules and regulations shall be deemed guilty of a misdemeanor, and upon conviction thereof shall be punishable by fine of not less than twenty-five nor more than one hundred dollars.

These rules and regulations were the beginnings of horticultural and agricultural quarantine and paved the way for the many effective laws and regulations which have figured so conspicuously in the protection and development of horticulture, not only in California, but in most other states in the United States, as well as in many foreign countries.

State Board of Horticulture

A State Board of Horticulture was created by an act (Chapter 63), approved by Governor G. Stoneman March 13, 1883. It provided for nine members to be appointed by the governor for a term of four years. One commissioner was to be chosen from each of the seven horticultural districts into which the state was divided, and two members from the state at large. Of the members chosen to the first board four of nine, selected by lot, were to be appointed for but two years, when successors to serve four years were to be chosen, thus partially renewing the board every two years.

The districts created for this purpose were the same as those previously adopted by the State Board of Viticultural Commissioners, and were:

First—The Sonoma District, which shall include the Counties of Sonoma, Marin, Lake, Mendocino, Humboldt, Del Norte, Trinity, and Siskiyou.

Second—The Napa District, which shall include the Counties of Napa, Solano, and Contra Costa.

Third—The San Francisco District, which shall include the City and County of San Francisco, and the Counties of San Mateo, Alameda, Santa Clara, Santa Cruz, San Benito and Monterey.

Fourth—The Los Angeles District, which shall include the Counties of Los Angeles, Ventura, Santa Barbara, San Luis Obispo, San Bernardino, and San Diego.

Fifth—The Sacramento District, which shall include the Counties of Sacramento, Yolo, Sutter, Colusa, Butte, Tehama, and Shasta.

Sixth—The San Joaquin District, which shall include the Counties of San Joaquin, Stanislaus, Merced, Fresno, Tulare, and Kern.

Seventh—The El Dorado District, which shall include the Counties of El Dorado, Amador, Calaveras, Tuolumne, Mariposa, Placer, Nevada, Yuba, Sierra, Plumas, Lassen, Modoc, Alpine, Mono, and Inyo.

An act (Chapter 7) to amend sections eight, nine, ten, eleven, and twelve of the above act, approved February 18, 1885, enlarged upon the duties of the secretary of the board, provided a salary of two hundred dollars per month and traveling expenses, not to exceed one thousand dollars per annum, for the inspector of fruit

pests, specified a biennial report of the board to the legislature, defined the duties of the treasurer, and provided an appropriation of ten thousand dollars per annum for maintenance.

The original law was further amended by an act (Chapter 36) to prevent the spreading of fruit and fruit tree pests and diseases, and to provide for their extirpation, approved March 10, 1885, and gave the State Board of Horticulture much needed power and authority, previously provided for only by quarantine rules. This act provided for the disinfection of fruit trees and boxes originating in known infested areas, before they could be transported elsewhere; to gather and dispose of or destroy all fruit infested by the codling moth, peach moth, red spider, plum weevil, and kindred noxious insects, their larvæ or pupæ, which fall from the trees, as often as once a week; inspection of fruit packages, trees, plants, cuttings, grafts, and scions imported into the state and, if infested with a disease or pest, to disinfect the same; disinfection of all fruit trees infested with insects or diseases, before the first day of April each year; and for a penalty for violations of the act.

On March 8, 1889, the act (Chapter 86) to create and establish a state board of horticulture was again amended to provide for: the biennial election of the officers; the appointment of a secretary to act also as an ex officio horticultural officer and a clerk of the Publishing and Quarantine Bureau of the board, the latter with power to enforce all rules and regulations regarding the spread of insect pests, quarantine districts or nurseries found to be infected; the appointment of quarantine guardians; the creation of an executive committee consisting of the president and the two commissioners from the state at large to have charge of the affairs of the board while not in session; the publication of an annual report; written reports from the County Boards of Horticultural Commissioners to be published by the State Board; and for experimental work in various sections of the state to be supervised by the secretary or clerk with an allotment of an amount not to exceed one thousand dollars for traveling expenses for the same.

On June 29, 1889, regulations [2] were adopted by the board to prevent the spread of contagious diseases among fruit and fruit trees; and for the prevention, treatment, cure, and extirpation of fruit pests, and of diseases of fruit and fruit trees; and for the

[2] State Bd. Hort., Calif., *Ann. Rept.*, 1889, pp. 468–470 (1890); *ibid.*, *Ann. Rept.*, 1890, pp. 12–14 (1890).

disinfection of grafts, scions, orchard débris, empty fruit boxes, etc. Specific remedies were prescribed as follows:

For disinfecting fruit trees, scions, etc.: whale oil soap, 5 pounds to 4 gallons of water.

For San José scale: potash, caustic soda, lime and fish oil mixture for summer remedy for peaches; resin wash for summer remedy for apples and pears; lime-sulfur-salt for winter remedy for all deciduous trees.

For brown apricot scale: resin wash for summer and lime-sulfur-salt for winter.

For cottony cushion scale: caustic soda (98%), 2 pounds; resin, 10 pounds; water 40 gallons.

For black scale: kerosene emulsion.

For red scale: resin wash.

For codling moth: Paris green, 1 pound to from 180 to 200 gallons of water.

For woolly aphis: for root form, dress liberally with ashes and gas lime, about 1½ shovelfulls of latter per tree; for branch form, kerosene emulsion or resin wash.

For borers: guard against sunburn with tree protector, use whitewash containing soap and sulfur.

For peach root borer: remove earth at base of tree and wrap up trunk with stout paraffine paper, and pile up against the paper air-slacked lime or ashes.

The above regulations were amended and greatly enlarged upon by action of the board on November 19, 1891. The ten regulations [3] adopted were in the nature of additions and had to do with inspection, quarantine, and disinfection. All fruit trees, stocks, roots, scions, cuttings, and pits, which are susceptible to peach yellows and peach rosette were prohibited; transportable materials infested by injurious insects or fungi were required to be dipped in boiling water containing not less than one pound of concentrated potash to each ten gallons of water, for a period of at least two minutes. Nursery stock, scions, grafts, cuttings, and pits were required to be fumigated with hydrocyanic acid gas. This appears to be the first recommendation for the use of HCN for this purpose, a practice which rapidly gained favor and was adopted throughout the country in the short space of five years.

On March 31, 1891, the law was again amended by an act (Chapter 194), appropriating a sum of five thousand dollars for the purpose of sending an expert to Australia, New Zealand, and adjacent countries, to collect and import into California, parasites and predacious insects for distribution.

[3] State Bd. Hort., Calif., *Ann. Rept.*, 1891, pp. 28–30 (1892).

The State Board of Horticulture which was created in 1883 was replaced by a State Commissioner of Horticulture by an act of the legislature approved March 25, 1903.

Of the officers on the board the most notable was Ellwood Cooper, who acted as president of the board from its beginning and who successfully guided its destinies more than any one else. Other important officials were M. G. Vallejo, who served as treasurer until his death in 1890; B. M. Lelong, the very efficient secretary and horticultural officer who served from 1887 until his untimely death in 1901; S. F. Chapin, W. M. Boggs, and W. G. Klee, all as inspectors of fruits, Sol Runyon, prominent orchardist; G. N. Milco, founder of the Buhach industry in California and otherwise prominent in horticulture, N. R.. Peck, afterwards horticultural commissioner in Placer and San Mateo counties; A. S. Chapman, citrus grower of Los Angeles County; L. W. Buck, fruit grower at Vacaville; A. Block, prominent orchardist at Santa Clara; I. H. Thomas, one of the originators of lime-sulfur as an orchard spray; and many others, all of which were prominent in the early development of horticulture in California.

State Commissioner of Horticulture

By an act of the legislature, approved by Governor George C. Pardee, March 25, 1903, the State Board of Horticulture, which was first organized on March 4, 1881, as a branch of the Board of State Viticultural Commissioners, went out of existence, and as its successor there was created the office of State Commissioner of Horticulture. This act provided for the appointment by the governor of a single commissioner of horticulture for a term of four years, at a salary of two hundred and fifty dollars per month and a sum not to exceed five hundred dollars for traveling expenses per annum. The commissioner was authorized to have the main office in Sacramento and another office in San Francisco. For the discharge of the duties he was further authorized to employ a clerk at fifteen hundred dollars per year, a deputy commissioner at two hundred dollars per month to have charge of the San Francisco office, and such temporary deputies as may be necessary. His duties and powers were practically the same as those of the State Board of Horticulture. He was authorized to establish, with the approval of the Governor, quarantine rules, regulations and orders, and was required to report in January of even-numbered years to

the Governor, and every odd-numbered year to the legislature. A sum of four thousand dollars was appropriated for the fiscal years 1903–1904.

This new law did not include provisions for the appointment of quarantine guardians and therefore there were no such officials from March 25, 1903, until the enactment of a separate law (Assembly Bill No. 965) was signed March 25, 1911, authorizing the State Commissioner of Horticulture to commission all county horticultural commissioners, their deputies and inspectors as quarantine guardians, thus restoring these valuable officials to the free service of the state.

Pardee appointed Ellwood Cooper, who had served continuously from the beginning as president of the State Board of Horticulture, as the first State Horticultural Commissioner on May 1, 1903.

This act was amended a number of times, first on March 20, 1905, enabling the Commissioner to appoint a secretary at a salary of twenty-one hundred dollars per annum and defining the duties of such officer. The office of clerk was thereby abolished and John Isaac was appointed secretary.

Ellwood Cooper was an earnest believer and advocate of the biological method of controlling insect pests and gave a great deal of his time to the introduction and distribution of predacious and parasitic insects. He was influential in securing the appointment and afterwards the maintenance of Albert Kœbele in the foreign field and during his term as State Commissioner of Horticulture, secured the services of George Compere, who collected in many parts of the world and forwarded a great many insects to California.

During the years 1890–1905 he became actively interested in the Mexican orange maggot, *Anastrepha ludens* (Loew).[4] An embargo was placed on Mexican citrus fruits which resulted in a voluminous correspondence. In 1902 John Isaac was appointed commissioner to investigate the prevalence of the pest in Mexico, which he did and submitted a lengthy report which was published by the commissioner as a special report.[5]

During his last few years in office he called attention to the seriousness of the gypsy moth and brown-tail moth in New England

[4] In 1899 Alexander Craw, Horticultural Quarantine Officer of the State Board of Horticulture first discovered this pest at San Francisco in a shipment of oranges from Acapulco, Mexico.

[5] *Report of the Commissioner appointed to investigate the prevalence of* Trypeta ludens *in Mexico*, Calif. State Hort. Commr., 48 pp., 2 figs., 9 pls., 1 map (1905).

and also coöperated freely with the U. S. Department of Agriculture and the California Agricultural Experiment Station in the campaign against pear blight conducted by M. B. Waite.

In 1905 he first received word concerning the seriousness of the citrus white fly, *Dialeurodes citri* (Riley and Howard), to the citrus industry of Florida and Louisiana and for the protection of California he formulated and put into effect Quarantine Order No. 1 relating to this pest on October 3, 1905. This order excluded citrus fruits and nursery stock from Florida and was enlarged to include all fruit and nursery stock and plants from Florida and Louisiana.

In June, 1907, this pest was discovered in the City of Marysville and subsequently during the same year at Bakersfield and Oroville. An eradication campaign was undertaken between February 1 and February 15, 1908, at all three places. At Bakersfield[6] and Oroville the insect disappeared completely for many years. At Marysville a much more difficult problem was encountered and the work, which extended over two years, 1907–1908, was far from satisfactory. This unsuccessful campaign had a great deal to do with the retirement of Cooper at the end of his term in October, 1907. The work on the white fly[7] was continued by his successor without any notable accomplishments.

The entire act was codified as Sections 2319–2319j of the Political Code by the state legislature in 1907.

In 1907, Governor J. N. Gillett appointed John W. Jeffrey, formerly member of the Board of Horticultural Commissioners of Los Angeles County, as State Commissioner of Horticulture.

In 1908 George Compere was listed as collector of beneficial insects and in 1910 was special field agent. E. J. Branigan was field agent, William Wood quarantine inspector, B. B. Whitney, assistant quarantine inspector, and Frederick Maskew, assistant superintendent of the state insectary. In March, 1911, just prior to the new law the officers were: special field agent, George Compere; field agent, E. J. Branigan; in charge of quarantine, O. E. Bremner; deputy quarantine officer, S. Strong; assistant inspector, B. B. Whitney; superintendent state insectary, E. K. Carnes; deputy superintendent state insectary, F. Maskew.

Jeffrey continued the eradication work on the white fly at Marysville during the winter of 1907 and 1908. In all about $20,000

[6] The species at Bakersfield was apparently completely eradicated.
[7] See article on the citrus white fly, pp. 156–163.

were spent by the state for the two campaigns. A large amount, however, was charged to the owners and this caused considerable friction in Marysville.

The citrus white fly quarantine order was amended April 1, 1910, to include fruit pits, and added all territory known to harbor the insect. Orange seeds could be admitted under restrictions and disinfection.

For the protection of the new cotton industry in the Imperial Valley the cotton boll weevil Quarantine Order No. 2, was issued April 23, 1908.

In order to keep Tulare County free from citrus pests, Quarantine Order No. 3 was issued January 17, 1910. It provided for quarantine restrictions and certain definite points of entrance and inspection of all citrus nursery stocks and plants shipped into the county. This order continued until revoked by Order No. 37 issued by G. H. Hecke, September 30, 1921.

The melon fly quarantine (Order No. 4) followed on March 28, 1910, the potato eelworm quarantine (Order No. 5) designed to keep out certain Nevada potatoes infested with nematode, and the Mediterranean fruit fly quarantine (Order No. 6) followed on June 24, 1911.

In order to provide for quarantine guardians, Jeffrey secured the passage of Assembly Bill No. 965, which was signed by the Governor March 25, 1911. He at once appointed the county horticultural commissioners in thirty-seven counties and a member of the board of county horticultural commissioners in the four counties not yet organized under the law of 1909.

A revised act approved April 26, 1911, provided for a raise in the Commissioner's salary to $4,000 per annum; for the arrangement of his office into three divisions; executive office, quarantine division, insectary and pathological division; provided for a chief deputy at a salary of $2,400 per annum; a secretary and a chief deputy quarantine officer at a like salary; a deputy quarantine officer at $1,800 per annum; a superintendent of the state insectary at $2,400 per annum, an assistant and a field deputy, each at $1,800 per annum.

At the expiration of Jeffrey's term, Hiram Johnson appointed A. J. Cook, professor of biology at Pomona College and leading horticulturist of southern California, as State Commissioner of Horticulture. Cook assumed office on October 21, 1911, and en-

deavored to completely reorganize the personnel and work of the Commission. He met with strong opposition at first, but his sincerity of purpose and general efficiency gradually gained the confidence of his opponents, and while his first three years were stormy, his fourth year was such that he was reappointed by Johnson and served until his death on September 29, 1916.

One of his first acts was to send a representative, H. A. Weinland,[8] to Hawaii to investigate and assist in the repression of the Mediterranean fruit fly there. He at once ordered an inspection of the areas previously known to have been infested with the citrus white fly.[9] It was not found at Oroville or Bakersfield, but was becoming rather abundant at Marysville and Sacramento. All infested trees in Marysville were sprayed during December, 1911–January, 1912, with a mixture of distillate and caustic soda to defoliate the trees. The infestation in Sacramento was fumigated in the winter of 1912–1913. While no attempt was made to eradicate the pest it was so greatly reduced in numbers as to be of little danger to the rest of the state. The quarantine on the Southern States relative to the citrus white fly was reissued as Order No. 15, August 30, 1912, and enlarged to include *Aleyrodes nubifera* Berger[10] and the territory extended and the list of hosts greatly augmented.

A regular periodical known as the Monthly Bulletin[11] and devoted to the descriptions, life habits, and methods of control of insects, fungus diseases, and noxious weeds and animals, especially in their relations to agriculture and horticulture, was begun in 1911 and has been continued as a valuable publication of the State Commissioner of Horticulture and later of the State Department of Agriculture.

The potato eelworm problem was also a new and difficult one to handle, particularly because the species of nematode involved was wrongly determined as *Tylenchus devastatrix* Kühn.[12] When the

[8] Weinland, H. A., *The fruit fly menace and preventive measures*, Calif. State Commr. Hort., Mthly. Bul., vol. 1, pp. 156–159 (1912).

The Mediterranean fruit fly in Hawaii, *ibid.*, pp. 261–270, figs. 111–115; pp. 570–580, figs. 177–181; pp. 845–852, figs. 261–265 (1912).

[9] In April, 1909, two infestations of the citrus white fly were discovered in Sacramento near the Capitol grounds.

[10] This species is now considered to be a synonym of *Dialeurodes citrifolii* (Morgan).

[11] Volume 1, No. 1 appeared in December, 1911, but this number was added to the twelve numbers issued in 1912 to complete the first volume.

[12] This species now known as the bulb nematode, *Tylenchus dipsaci* Kühn, was first taken on narcissus bulbs in Humboldt and Santa Cruz counties in 1924 and in Alameda County in 1924; Calif. State Dept. Agr., *Mthly. Bul.*, vol. 14, pp. 182–187 (1925).

species was definitely determined as the common root knot nematode, *Heterodera radicicola* Greef, known to occur in California, the previous quarantine Order No. 5 and rules were repealed by Order No. 7, issued December 23, 1911. The latter contained certain qualifications for admitting Nevada potatoes and was finally revoked by Order No. 25, issued by A. J. Cook, December 12, 1914.

The Mexican orange maggot was also definitely barred from the state by Quarantine Order No. 10, issued January 29, 1912.

The alfalfa weevil attracted the Commissioner's attention almost as soon as he came into office and in the first issue of the monthly bulletin he called attention to it as an alarming pest.[13] A quarantine was placed against certain counties in Utah, Idaho, and Wyoming by Order No. 14, issued August 13, 1912. This order was subsequently revised to include new territory due to the natural spread of the insect.

In addition to quarantine orders, the state commissioner of horticulture issued quarantine regulations designed to regulate the entrance of certain commodities into the state. They did not require the signature of the governor. Cook issued a number of these.

Cook was very much interested in the passage of a national quarantine law and exerted a great influence to this end. He not only interviewed and corresponded freely with the California representatives in Congress, but he was responsible for the passage of Senate Joint Resolution No. 10 to urge Congress to pass the Simmons quarantine bill. Through the efforts of William Kent, in the House of Representatives, the law was passed and approved August 20, 1912. The passage of this act and subsequent orders of the Federal Horticultural Board created by it had a marked influence on the quarantine work in California. The Federal Board at once took over the inspection of all foreign plant materials and gave the state quarantine officials federal appointments. The law eliminated the Mediterranean fruit fly control work being done by the state in Hawaii and it made null and void the state quarantine orders such as the ones on the Mediterranean fruit fly and the Mexican orange maggot which dealt with foreign pests; and it very greatly restricted the introduction of agricultural commodities which were likely to carry insect pests and plant diseases.

The standardization of fruit packing (Chapter 659), and the apple standardization act (Chapter 712), approved June 10, 1915,

[13] Calif. State Commr. Hort., *Mthly. Bul.*, vol. 1, pp. 19–22 (1911).

constituted the first legal steps taken to insure uniform size and quality of the fruit pack in the state.

Cook endeavored to secure trained men for the various offices which he filled and the fact that many of his appointees continued in service under G. H. Hecke is an indication of his ability to pick his force.

On the death of Cook, September 29, 1916, Governor Johnson appointed G. H. Hecke, the horticultural commissioner of Yolo County, as his successor. Hecke continued in the main the program of work as laid down by his predecessor. He strengthened the commission very materially by securing the enactment of laws relating to the certification of potato seed, approved May 27, 1919; control and destruction of predatory animals, approved May 5, 1919; and the development of the various standardization laws. His appropriations were greatly increased and the work very materially expanded so that in 1919, just prior to the creation of the State Department of Agriculture, he had segregated his officials in groups or divisions.

California Department of Agriculture

By an act of the state legislature approved July 22, 1919, the office of Commissioner of Horticulture, as such, was abolished and in its stead was created a Department of Agriculture to be presided over by a Director of Agriculture appointed by the Governor. Into the Department were consolidated a number of state offices, including the State Commissioner of Horticulture; Board of Viticultural Commissioners,[14] Office of State Veterinarian; State Board of Cattle Protection; State Dairy Bureau; and the Offices administering the Insecticide and Fungicide Act; and the Fertilizer Act.

The efficient organization and direction of this large department has been a great credit to Director Hecke. Every department has steadily increased in size and importance and no phase of the work has been neglected. He has personally assumed the duties previously conferred upon the Commissioner of Horticulture. For administrative purposes the Department of Agriculture was organized as follows: the Executive Office, the Division of Agricultural Chemistry, the Division of Plant Industry, and the Division of Animal Industry. All of these excepting the latter are in part

[14] This new Board of State Viticultural Commissioners, modeled somewhat after the pattern of the old board created in 1881, was provided for by an act approved May 28, 1913. It had nothing to do with pest control or law enforcement.

concerned with agricultural and economic entomology in relation to law enforcement. In fact the Department of Agriculture stands for law enforcement whereas the Agricultural Experiment Station stands for research.

The insecticide law is administered by the Division of Chemistry and quarantine by the Division of Plant Industry.

Since the organization of the Department of Agriculture a number of other offices have been incorporated with it, as bureaus or divisions, such as Dairy Control, Weights and Measures, Land Settlement, Markets, State Fish Exchange, Coöperative Crop Reporting Service, Coöperative Market News Service, and Federal-State Market News and Grading Service.

County Boards of Horticultural Commissioners

County boards of horticulture were created by an act (Chapter 75) to protect and promote the horticultural interests of the state, approved March 4, 1881, which provided as follows:

1. Appointment of a board of three members.
   a. On receipt of a petition of five or more resident freeholders and possessors of an orchard, stating that certain or all orchards, or nurseries are infested with insects and requesting the appointment of said board.
   b. Appointment to be made within twenty days after receipt of petition.
   c. Members to serve period of three years and removable at will of the board of supervisors.
2. Duties of county boards.
   a. Inspect premises reported infested with injurious insects.
   b. Notify owners or persons in charge of their findings.
   c. Require the proper control of insect pests.
      (a) By owner or persons in charge.
      (b) By legal process of law.
   d. Keep a record of official doings and report before the first day of November, every year to the board of state viticultural commissioners.
3. Division of the county into districts and the appointment of a local inspector for each district. Duties of inspectors to be prescribed by the boards.
4. Salaries of five dollars for each county commissioner and inspector for every day actually engaged in the performance of his duties.
5. Appointment by any commissioner of one or more assistants to serve without pay.
6. Removal of any board and appointment of successors by the supervisors.
7. Elimination of vineyards or their products from the provisions of the act.

The above law was amended by an act approved March 19, 1889, as follows:

1. Appointment of boards.
   a. On receipt of a petition signed by twenty-five freeholders and possessors of an orchard.
2. State board of horticulture or state quarantine officer to issue commissions as quarantine guardians to members of county boards of horticulture and their inspectors.
3. Salaries to be determined by the boards of supervisors.

An act (Chapter 177), approved March 31, 1889, added a new section (Section 2) to the effect that the board of supervisors could appoint any number of county horticultural commissioners less than three at a compensation each of not less than four dollars per day each; if only one member was appointed, the salary was to be five dollars per day.

Another amendment (Chapter 188), approved March 31, 1891, provided that the county boards of horticultural commissioners should:

1. Inspect orchards, premises, etc., for insect pests and plant diseases.
2. To serve notices on owners or lessees to control or eradicate the same within a certain time.
3. If the pest was not abated as required then the commission was to cause the same to be done at the expense of the county.
4. Costs to the county were to become a lien on the property.

There was some resistance on the part of certain county boards of supervisors to appoint county boards of horticulture as provided by this act. In the case of Sonoma County, John G. Pressley, Judge of the Superior Court of that county, on June 19, 1889, rendered a decision to the effect that the appointment of county boards of horticultural commissioners was mandatory upon the boards of supervisors. This decision quieted all further opposition and by the end of 1889 commissioners were appointed in the counties of Alameda, Butte, Colusa, Eldorado, Humboldt, Kern, Los Angeles, Mendocino, Nevada, Orange, Placer, San Benito, San Bernardino, San Joaquin, San Mateo, Santa Barbara, Sonoma, Sutter, Tulare, Ventura, and Yuba.

In the same year the county boards of horticultural commissioners of San Bernardino, Mendocino, and San Mateo counties petitioned the state board of horticulture to have all their inspectors, twenty-four in number, appointed quarantine guardians,

which request was granted. In this year there were county boards in the following counties: Alameda, Butte, Colusa, Eldorado, Humboldt, Kern, Los Angeles, Mendocino, Nevada, Orange, San Benito, San Bernardino, San Joaquin, San Mateo, Santa Barbara, Sonoma, Sutter, Tulare, Ventura, and Yuba.

By an act of the state legislature, approved March 20, 1905, the following changes are noted:

Appointment of a board.
- Weeds included with insect pests in petition.
- Removable upon petition of twenty-five resident freeholders and possessors of an orchard, after hearing by board of supervisors.

Duties of county boards.
- Weeds added.
- Report to board of supervisors.

Salaries.
- Commissioners to receive four dollars per day.
- Inspectors to receive two dollars and fifty cents per day.

In 1907 the act relating to county boards of horticulture was, with verbal changes merely, codified as Sections 2322–2322c of the Political Code.

The county boards went out of existence with the passage of an act (Chapter 299) relating to the county commissioner of horticulture, approved March 25, 1911. By this act a single commissioner replaced the former board of three members. In other respects the law remained virtually the same. The few exceptions were:

1. Board of horticultural examiners.
   a. Created to give examinations to qualify candidates.
2. Appointment of county horticultural commissioner or deputy.
   a. Qualified by competitive examination.
   b. Appointed by board of supervisors.
   c. To serve for four years or until a successor was appointed.
3. Provided for the issuance of commissions as quarantine guardians to county horticultural commissioners, deputies, and inspectors by state commissioner of horticulture.[15]
4. Duties.
   Report on or before the first of each October to the state commissioner of horticulture.
   Attend annual meetings of state association of county horticultural commissioners and meetings required by state commissioner of horticulture.

[15] This important function was unfortunately overlooked in drawing up the law of 1903.

5. Salaries—When actually engaged in discharge of duties.
   For the commissioner six dollars per day.
   For the deputy commissioner five dollars per day.
   For the inspectors three dollars and fifty cents per day.

Following the approval of this act by Governor Hiram Johnson, State Commissioner of Horticulture J. W. Jeffrey issued, from April 6 to July 1, 1911, commissions as state quarantine guardians to commissioners of thirty-seven counties and to a member of the board of horticultural commissioners of four counties.[16]

In 1912 there were single commissioners in the counties of Alameda, Butte, Colusa, Contra Costa, Eldorado, Fresno, Imperial, Kern, Kings, Lake, Los Angeles, Madera, Mendocino, Merced, Monterey, Napa, Nevada, Orange, Placer, Riverside, Sacramento, San Benito, San Bernardino, San Diego, San Joaquin, Santa Barbara, Santa Clara, Santa Cruz, Shasta, Siskiyou, Solano, Sonoma, Stanislaus, Sutter, Tehama, Tulare, Ventura, Yolo and Yuba, and county boards of horticultural commissioners in Humboldt, Inyo, and Lassen. By 1914 all of the latter had single commissioners. Modoc County was added in 1914, San Francisco in 1915, and Marin and San Luis Obispo in 1916.

As a result of an amendment to section 2319c relating to the duties of the State Commissioner of Horticulture, all county horticultural quarantine ordinances became null and void after August 8, 1915.

In 1916 the following amendments to the county horticultural commissioner act were made: [17]

1. Ground squirrels and gophers are added to the list of pests that the county horticultural commissioner is ordered to eradicate or control.
2. If, for any reason, a board of supervisors refuses or neglects to appoint a county horticultural commissioner as required by law, the State Board of Horticultural Examiners shall appoint from the list of qualified persons.
3. In case the county horticultural commissioner exercises his authority to compel eradication or control of plant diseases, insect, animal or weed pests, a lien is filed upon the property sufficient to cover the cost of such eradication or control. Said lien shall take precedence over and be paramount to all other liens upon the land excepting only the lien of taxes.
4. Provision is made for traveling expenses of county horticultural inspectors when within their respective counties. County horticultural

[16] *Quarantine laws and orders*, Calif. Comm. of Hort., Bul. 9, p. 3 (1911).
[17] Calif. State Com. Hort., *Mthly. Bul.*, vol. 6, p. 53 (1916).

commissioners shall be paid traveling expenses when working outside the counties, when such service has been authorized by the supervisors.

5. County horticultural commissioners may be paid either one thousand eight hundred dollars per annum, or six dollars per day at the option of the county boards of supervisors.
6. Statutory provision is made for holding imported plants at destination until they have been inspected.
7. Uniform treatment and disposal of infected shipments is provided.
8. County horticultural commissioners are given power to grant permits upon examination, to public sprayers and fumigators.
9. The words "or control" are added wherever "eradicate" is mentioned, thereby making it possible to force control measures when eradication is impossible.

In 1921 the county commissioner act was further amended and greatly extended; enlarging the powers of the commissioner to include standardization of fruits and vegetables, rodent control, weeds, insecticides, and seeds; providing for his removal; permitting the boards of supervisors to fix his salary (at not less than six dollars per day or eighteen hundred dollars per year); and delegating certain powers to the director of agriculture.

Amendments approved June 22, 1923, fixed the salaries of commissioners in all the counties of the state—there being a separate class for each county—and salaries ranging from one dollar per annum in Alpine County of the fifty-eighth class, which now has no commissioner, to thirty-nine hundred dollars for Los Angeles, a county of the first class, and forty-two hundred dollars for Orange, a county of the fourth class; and all variations between. At this date only the counties of Alpine, Mariposa, Mono, Sierra, and Trinity were without county horticultural commissioners.

In 1930 the title of County Horticultural Commissioner was changed to County Agricultural Commissioner and a similar change was also made for the inspectors.

California Insecticide Laws

The first insecticide law in California designed to prevent fraud in the sale of Paris green used as an insecticide became effective on February 28, 1901.[18] It provided:

[18] New York first enacted a law to regulate the sale of Paris green in 1898. Oregon and Texas followed in 1899, California, Washington, and Louisiana in 1901, New Jersey in 1906, and Minnesota in 1909. The Federal Insecticide Act of 1910 gave much needed protection to the whole country. Nearly all of the state insecticide laws have since been amended to conform with the Federal law. [Gray, G. P., *Jour. Ind. and Eng. Chem.*, vol. 6, p. 590 (1914).]

Colby, Geo. E., Calif. Agr. Expt. Sta., *Bul. 182*, pp. 182–183 (1906).

1. That manufacturers submit samples of Paris green to the Director of the California Agricultural Experiment Station.
2. That all containers be marked, giving the contents and amount of a combined arsenic.
3. That certificates be issued to manufacturers or agents authorizing them to sell Paris green.
4. That Paris green, when sold, offered or exposed for sale, as an insecticide, in this state, shall contain at least fifty per centum of arsenious oxid, and shall not contain more than four per centum of the same in the uncombined state.
5. For examination and analysis of such insecticidal materials by the Director of the Agricultural Experiment Station.
6. For fines for the violations of the act.

The administration of this law was placed with the Director of the Experiment Station, E. J. Wickson, who delegated it to C. W. Woodworth, Entomologist, who in turn secured the services of an able chemist, G. E. Colby, who has had much to do with this work to the present day.

This first law was replaced by the California Insecticide Law,[19] approved May 1, 1911, and which became effective July 1, 1911. It required:

1. Manufacturers, importers and dealers in insecticides and fungicides to register on or before the first day of July of each year and obtain from the Secretary of the Board of Regents of the University of California a certificate of registration authorizing the sale of insecticides in the state and also to file with the Director of the Agricultural Experiment Station of the University of California, a statement under oath of the component parts of the substances to be sold under each name or brand.
2. The proper labelling of insecticides and fungicides stating:
   (1) Name, brand and trade mark, if any.
   (2) Name and address of manufacturer, importer or dealer.
   (3) Place of manufacture.
   (4) Chemical analysis:
      (a) Percentages of substances having insecticidal or fungicidal properties.
      (b) Specifying form in which each is present and materials from which derived.
      (c) Percentages of inert ingredients. When the material is sold for less than one-half cent per pound only a general statement was required.
   (5) The word "Register" with the number of registry.
   (6) Deputies or inspectors to collect samples.

[19] Woodworth, C. W., Calif. Agr. Expt. Sta., *Circ. 65*, 23 pp. (1911).

(7) Fees.
  (a) Registration fee, $1.00
  (b) Analytical fee, $1.00
(8) To publish analysis of samples taken.

The purpose of this act was to prevent adulteration and misbranding and to provide for the proper labeling and registration of all materials offered for sale as insecticides and fungicides. The administration of this law was the same as that of the preceding, with the exception that Geo. P. Gray succeeded Colby as chemist in 1911. The work of sampling soon became an almost impossible task. In the annual report of the Director [20] for the year ending June 30, 1913, it is stated that "the insecticide inspection required the work of seven inspectors, who traveled by rail, stage and boat, approximately 9672 miles, visited 332 towns, and rendered detailed reports on the insecticides stocked by 1631 dealers of whom 984 were operating under licenses issued by the University, the balance handling only registered goods in original packages. The number of brands registered and labels inspected was 9646, the number of samples taken up was 777 and of the analyses made was 553."

In 1913 the State Legislature passed two amendments to the above law to:

1. Abolish the system of registration.
2. Authorize the purchase of samples instead of collecting them through inspectors.
3. Substitute a general statement of the nature of the contents instead of giving the percentage amounts of active ingredients.
4. Allow samples to be acquired any time.
5. Abolish specification of the method of analysis.
6. Exempt "drugs and chemicals listed in the U. S. Pharmacopœia and National Formulary and medicinal and toilet preparations guaranteed under the U. S. pure food and drug laws."
7. Provide a new section in which insect powders, poison fly paper, sticky fly paper, borax, moth balls, gum camphor, spirits of camphor, blue ointment, oil of eucalyptus, castor oil, ant poison, sheep dip, lice killer, sulfur and bluestone, used as insecticides and fungicides, may be sold by grocers and dealers generally without restriction and without the registration fee, permit or license being required of them.[21]

[20] Calif. Agr. Expt. Sta., *Ann. Rept.*, 1912–1913, p. xxiii (1913).

[21] Gray, G. P., *The workings of the California Insecticide Law*, Jour. Ind. and Eng. Chem., vol. 6, p. 590 (1914).

On July 1, 1920, the administration of the insecticide law was transferred to the Director of the State Department of Agriculture, Sacramento, and a Division of Chemistry with G. P. Gray as Chief was created. G. E. Colby as chemist, with two assistant chemists and two laboratory assistants composed the staff. This change was brought about to segregate all law enforcement work under the Department of Agriculture and all of the investigational work in the Agricultural Experiment Station and the College of Agriculture.

The above law was replaced by the Economic Poison Act of 1921, approved June 3, 1921, which provided for the following:

1. Administration of the act by the director of agriculture.
2. Take samples of economic poisons, make analysis or examination thereof, and make investigation concerning the use, sale, adulteration or misbranding of economic poisons.
3. Publish the results of examinations or chemical analysis of official samples of economic poisons.
4. Give notice of violations and conduct hearings of same.
5. Defines economic poisons as any substance or mixture of substances intended to be used for preventing, destroying, repelling, or mitigating any and all insects, fungi, weeds, rodents, or other plant or animal pest, collectively or individually, which may infest or be detrimental to vegetation, man or other animals or households, or be present in any environment whatsoever.
6. Defines adulterated poison, and misbranded poison.
7. A label stating the name, brand or trademark, name and address of the manufacturer, importer, or dealer and the place of manufacture.
8. Exempts drugs and chemicals of the U. S. Pharmacopœia or National Formulary and medicinal and toilet preparations guaranteed under the U. S. pure food and drug act of June 3, 1906 and the California pure food and drugs act of 1907.
9. Issue certificates of registration to all manufacturers, importers, agents or dealers—same to cost $50.00.
10. Power to cancel or refuse registration in case materials have little or no value for the purpose for which they are recommended.
11. Disposal of seized poisons.
12. Penalty for violations.
13. A report on all moneys received at least once a month to the state controller.

Quarantine

California's program for the regulation of insect pests by legal methods included horticultural and entomological quarantine, which had never before been experimented with by any state, or country. In the substantiation of this claim Riley [22] may be quoted

[22] Riley, C. V., *Insect Life*, vol. 6, p. 208 (1894).

as follows: "So far as we know California took the lead in regard to this matter of quarantine, and if this state succeeds in making its measures in this direction effective, it will deserve the gratitude of the fruit-growers of the entire country." It is no longer necessary to question the success of these measures. They succeeded, but not always to the gratitude of the fruit-growers of other states and countries. The principle, however, was valuable and because of this fact, has endured. Other states, the Federal Government, Canada, and a number of foreign countries notably Australia, New Zealand, South Africa, and Japan have adopted this idea of horticultural quarantine and are deriving from it the benefits that have been so well demonstrated in this state. It is true that quarantine does not absolutely prohibit for all time certain pests which may eventually reach our shores, but it does indefinitely postpone and delay such introductions. Such postponements may be of sufficient duration to permit a careful study of the undesirable pest in its native environment and thereby furnish the information necessary to cope with it when finally introduced into a new region.

The carrying out of quarantine measures, particularly the inspection of personal baggage, calls the attention of the general public to the necessity of insect pest exclusion and control and thereby assists in many ways, the work of entomologists at home and abroad.[23]

The first state quarantine law was approved March 11, 1899, and provided for the protection of horticulture by preventing the introduction into this state of insects or diseases, or animals, injurious to fruit or fruit trees, vines, bushes or vegetables; a quarantine for the enforcement of the act, a penalty for the violation of the terms of the act; the immediate enforcement of the act; and the repealing of a certain act entitled. " An act for the protection of horticulture and to prevent the introduction into this state of insects, or diseases, or animals, injurious to fruit or fruit trees, vines, bushes or vegetables, and to provide for a quarantine for the enforcement of this act."

In order to meet the situation arising from the presence of the Mediterranean fruit fly in Hawaii and elsewhere, a definite request was made by State Horticultural Commissioner Cook and fruit growers to Governor Johnson in November, 1911, for a new quarantine law. That the governor realized the importance of the need of

[23] Essig, E. O., *Plant Quarantine*, Science, vol. 71, pp. 350–353 (1930).

such action is shown by the fact that on December 24, 1911, he called a special session of the State Legislature to consider the passage of a more adequate state quarantine law. The bill submitted passed a few minutes after its final reading and was approved by the governor on January 2, 1912. It repealed the quarantine law approved March 11, 1899, and provided for:

1. Inspection of all plant products coming into the state.
2. Disinfection, removal, or destruction of all infested materials.
3. Marking of all plant materials brought into the state.
4. Proper sealing of containers of infested plant materials passing through the state.
5. Prohibition of plant hosts of the fruit fly family Trypetidæ from all places where these flies are known to exist.
6. Prohibition of peach stocks and seeds from regions infested with peach yellows and peach rosette.
7. Prohibition of English or Australian wild rabbit, flying fox, mongoose or other animals detrimental to agriculture.
8. Penalties for violating provisions of the act.

In 1921 this act was amended so that the "director of the department of agriculture" replaced the "state commissioner of horticulture," without other changes.

The various legal quarantine activities of the present State Department of Agriculture have been outlined for me by A. C. Fleury as follows:

(1) Quarantine Orders, issued under authority of section 2319b of the Political Code, and which are special quarantines issued by the Director of Agriculture and approved and proclaimed by the Governor; (2) Quarantine Circulars, which have no basis in law, but represent an explanatory or interpretive statement issued by the Director of Agriculture, giving all concerned a detailed interpretation of some provision set forth in the law, such as the peach yellows regulation of the State quarantine law, or advising all concerned of the application of the "reasonable cause to presume" clause of the State quarantine law against some particular pest; and (3) Quarantine Regulations, which will be based upon section 2319c of the Political Code, and which gives the Director of Agriculture authority to issue such other regulations in addition to the establishment of quarantines as provided in section 2319b, as he may deem necessary to circumvent or prevent the introduction or spread of pests within the state. We expect to confine these quarantine regulations to pests established within the state but not generally disseminated.—January 28, 1930.

State Quarantine Orders

An act to create a State Commission of Horticulture, approved March 25, 1903, and amended March 20, 1905, definitely provided

for the promulgation and enforcement of horticultural quarantine in California. Three sections specifically related to this subject and in substance contained the information given in Section 4 as follows:

SECTION 4. Said Commissioner may, by and with the approval of the Governor, establish, maintain and enforce such quarantine regulations as may be deemed necessary to protect the nurseries, trees, shrubs, plants, vines, cuttings, grafts, scions, buds, fruitpits, vegetables, or other articles of horticulture, against contagion or infection by injurious disease, insects or pests by establishing such quarantine at the boundaries of this state or elsewhere within the state, and he may make and enforce, with the approval of the Governor, any and all such rules and regulations as may be deemed necessary to prevent any infected stock, tree, shrub, plant, vine, cutting, graft, scion, bud, fruitpit, fruit, vegetable, or other article of horticulture, from passing over any quarantine line established and proclaimed pursuant to this Act, and all such articles shall, during the maintenance of such quarantine, be inspected by such Commissioner or by a deputy appointed in writing by said Commissioner with the approval of the Governor, and he or the deputy so conducting such inspection shall not permit any such article to pass over such a quarantine line during such quarantine, except upon a certificate of inspection signed by such Commissioner or in his name by such a deputy who has made such inspection, unless such article has been immediately prior to such passage inspected by an officer or agent of the United States entitled to inspect the same, and such officer or agent has granted permission for such passage. All approvals by the Governor given or made pursuant to this Act shall be in writing and signed by the Governor in duplicate, and one copy thereof shall be filed in the office of the Secretary of State, and the other in the office of said Commissioner before such approval shall take effect.

The act relating to the State Commissioner of Horticulture, approved April 26, 1911, authorized the commissioner, with the approval of the governor, to establish, maintain, and enforce such quarantine regulations as may be deemed necessary for the protection of the agricultural interests of the state.

The provisions of the act relating to quarantine were interpreted by State Horticultural Commissioner, J. W. Jeffrey [24] as follows:

In pursuance of this authority and without attempting to particularly interpret the law under consideration, this Act seems to the writer to separate the quarantine practice into two divisions.

Where the action establishes permanent quarantine lines or districts and which restrict or otherwise affect public rights the provisions plainly require the Governor's approval; where the quarantine is invoked to hold up and control a shipment or any article incidentally and does not involve the freedom of the public, the quarantine officers may handle the case by merely serving a

[24] *Quarantine Laws and Orders*, Calif. State Com. Hort., Bul. 1, p. 5 (1911).

quarantine notice upon the party in charge of the article to be detained. As the state quarantine guardians will have to do with the latter class of work only, the administration of the law is simpler, and they are thus authorized to proceed upon their own initiative to detain and handle contraband cases without the approval of other authorities. It was the intention of the framers of this Act to provide legal machinery for emergency cases, and at the same time restrict arbitrary, permanent action that might deal unjustly with the public. The right to quarantine an infected article of horticulture is a police power conferred by this statute. Its efficiency often depends upon the authority to act promptly. The Supreme Court has sustained this principle in holding that a horticultural quarantine law is constitutional, and that it must be made prompt and summary to be effective. It is plainly the intent of the law to give quarantine officers authority to act summarily in all emergency cases, obse ving the requirements of the act and abating or removing the danger as set forth and authorized by the Horticultural Quarantine law of 1899.

The succeeding commissioners, A. J. Cook and G. H. Hecke, usually followed this interpretation.

NATIONAL QUARANTINE [25]

Those who enjoy the protection of the national quarantine laws little realize the long and hard struggle which ensued in securing their final passage. C. L. Marlatt, the champion of these laws and in charge of their enforcement since their inception, has given the progress accomplished up to the final passage of the act and the later workings of the laws,[26] from which a part of this summary has been taken:

1897. First bill drafted in Washington, following the introduction of the San José scale into the eastern states. Failed to pass.

1899. Bill introduced into the House of the 56th Congress by Representative Wadsworth of New York, similar to the one drafted in 1897. Reported favorably by the Committee on Agriculture, but failed to pass.

1900. Wadsworth bill introduced into the Senate by Senator Perkins of California. Failed to pass.

1908. Wadsworth bill of 1899 again introduced into the Senate by Senator Flint. Died in the Committee on Finance. The chief objections

[25] Marlatt, C. L., *Pests and parasites. Why we need a national law to prevent the importation of insect-infested and diseased plants*, Nat. Geog. Mag., pp. 321–346, 30 figs. (April, 1911).

Wardle, R. A., *The problems of applied entomology* (New York, McGraw-Hill, 1929), pp. 505–519.

Ferris, G. F., *Science*, vol. 70, pp. 451–453 (1929); vol. 71, pp. 68–69 (1930).

Essig, E. O., *Plant Quarantine*, Science, vol. 71, pp. 350–353 (1930).

[26] *National Quarantine*, Jour. Econ. Entom., vol. 4, pp. 107–124 (1911).

Federal Plant Quarantine Act, *ibid.*, vol. 6, pp. 133–142 (1913).

The when and why of plant quarantines, *ibid.*, vol. 16, pp. 251–252 (1923).

of the opponents of this bill were aimed at the two clauses: (1) "to provide for the inspection and control of imported nursery stock, and (2) to have national supervision and inspection of homegrown stock wherever such was to become subject to interstate shipment."

1908. As a result of many shipments of nursery stock infested with the larval nests of the brown tail moth from Europe into many parts of the United States, Marlatt prepared a new bill in 1908.

1909. Marlatt's bill was reported out by the House Committee on Agriculture by Representative Scott and passed the House. It was also reported out of the Senate Committee on Agriculture and Forestry. However, it was strongly objected to by the legislative committee of the American Nurserymen's Association. To meet these objections it was decided to withdraw the bill and rewrite it.

1910. New bill presented to the 61st Congress by Simmons of New York. Failed.

1912. National Quarantine Act passed Congress August 20.

1912. Federal Horticultural Board appointed in September.

1912. September 16. First quarantine order, promulgated on white pine blister rust.

National quarantine has always been of great interest to California not only because of good results obtained through her own state quarantine legislation, but chiefly because of the need of protection through the acts of the federal government, which could not be obtained in any other way. This protection she sought, argued for, and fought for from the beginning. The attitude of the growers and horticultural officials is well explained in the words of the chief quarantine officer Alexander Craw in 1902:[27]

> Feeling as deeply as ever the vital necessity for a national quarantine law for the protection of our fruit industry against the importation of fruit or trees, plants, shrubs, vines, buds, or cuttings, commonly called nursery stock, infested with any disease, scale, or insect pest, we, the fruit growers of California, in convention assembled, hereby give our cordial approval to House Bill no. 96, introduced into the Fifty-sixth Congress by Wadsworth, and we do most earnestly request all members of Congress from California to use their best efforts to secure the enactment into law of the Wadsworth bill, or one embodying similar provisions establishing national quarantine regulations.

Upon his appointment to the position of State Commissioner of Horticulture of California in October, 1911, A. J. Cook was faced with many serious horticultural quarantine problems. The gypsy moth, brown-tail moth, alfalfa weevil, cotton boll weevil, sweet potato weevil, Mexican fruit fly, Mediterranean fruit fly, melon fly, olive fly, citrus white fly, peach yellows, peach rosette, white

[27] Calif. State Bd. Hort., *Proc. 26th Calif. State Fruit Growers' Conv.*, p. 51 (1902).

pine blister rust, and potato wart disease were some of the pests which were demanding the eternal vigilance of every quarantine officer in the state. It was only natural that he should have earnestly sought the aid of the federal government in this gigantic task. The aid desired was an adequate national horticultural law with sufficient "teeth" to become immediately effective in protecting the agricultural and horticultural interests of the entire country.

An editorial appearing in the first number of the Monthly Bulletin[28] will explain the situation at that time.

> The necessity of a suitable national quarantine law (one which will thoroughly protect) is made apparent by the fact that at the present time the neighboring states of Oregon, Washington, Nevada, Arizona, and the Republic of Mexico have very inadequate or no quarantine laws at all, and the introduction of pests across the borders is only checked by our own State laws. But even the State laws of California do not protect us from the importations in personal baggage, especially by way of rail from Mexico, and the adjacent States. A uniform national law, embodying the spirit of our own State laws, and providing for quarantine inspection at the port of entry rather than at the port of destination, and imposing strict quarantine upon localities known to be infested with destructive pests and diseases, will mean more to the agricultural interests of this country than perhaps any other one measure which could be enacted at the present time. Especially should California be represented in the making of this law. Every influence from our State legislature, our representatives in congress and all agricultural organizations and the leading fruit men, should be exercised to procure some concerted action to aid in the passage of the national quarantine law.
>
> This office is now endeavoring to get some such action from the state legislature which will show that California is not only interested in such a law, but that it is willing to do all in its power to make its passage assured.

Frederick Maskew,[29] chief quarantine officer, gave much valuable assistance in support of this project.

At this time there were several quarantine bills before Congress. The bill which created most interest, however, was the Simmons Bill. In its original form it was seriously objected to by growers and entomologists because it did not carry provisions for the inspection of nursery stock at the ports of entry, and the establishing of quarantine against foreign localities known to harbor dangerous insect pests or plant diseases. A general movement was begun in California early in 1912 to add these provisions to the final bill, and thus make it satisfactory to those who were not in favor of the

[28] Essig, E. O., Calif. State Hort. Com., *Mthly. Bul.*, vol. 1, p. 25 (1911).
[29] Calif. State Com. Hort., *Mthly. Bul.*, vol 1, pp. 49–50 (1912).

original bill. Cook began active correspondence with members of the Bureau of Entomology and with the California Senators and Representatives at Washington, D. C. He also brought the matter before the agricultural committees of the California Legislature, and succeeded in interesting that body to the extent that a joint senate and assembly resolution was passed favoring national quarantine.[30] Copies of this resolution were transmitted to the President and Speaker, respectively, of the Senate and the House of Representatives of the Congress of the United States, and to each of the Senators and Representatives from California with a request that the latter "use all honorable means to secure the passage of the Simmons Bill with the two provisions referred to above included." It is to the honor of California that all her Congressmen faithfully supported the desired quarantine legislation. On April 16, 1912, Representative Raker introduced a bill (H. R. 23413) which was in many ways superior to all others and still another bill (H. R. 22728) which contained the desirable features already referred to, was also introduced April 1, 1912.[31]

Action on the part of the fruit growers of California was taken at the 41st California State Fruit Growers' Convention, held at Santa Barbara, June 12–14, 1912, in the form of a resolution or memorial to the Senators and Representatives of California in Congress, calling attention to the Simmons Bill and asking their support of it. It was decided to support this particular bill in view of the fact that it appeared to be most acceptable to all parties concerned.

As a result of the activities of interested parties from all over the country, but particularly to those of C. L. Marlatt, and other members of the Bureau of Entomology, and in California to those of the members of the California Commission of Horticulture, particularly A. J. Cook, the California members in Congress, particularly William Kent and prominent California fruit growers, including C. C. Teague and James Mills, the Federal Plant Quarantine Act was passed and approved, August 20, 1912.[32]

On October 1, 1912, the Federal Government began the main-

[30] Calif. State Com. Hort., *Mthly. Bul.*, vol. 1, pp. 50–51 (1912).

[31] Essig, E. O., *ibid.*, vol. 1, pp. 240–242 (1912).

[32] Calif. State Com. Hort., *Mthly. Bul.*, vol. 1, pp. 791–795 (1912). Copy of National Quarantine Law.

tenance of a quarantine on the Pacific Coast, but inspectors were not deputized until sometime later.[33]

The Federal Horticultural Board, charged with the enforcement of the National Plant Quarantine Act, was appointed in the fall of 1912 and consisted of the following members: C. L. Marlatt, Assistant Chief, Bureau of Entomology, Chairman; W. A. Orton, Bureau of Plant Industry, Vice-Chairman; Peter Bissett, Bureau of Plant Industry; A. F. Burgess, Bureau of Entomology; George B. Ludworth, U. S. Forest Service.[34]

The act was effective as to certain quarantines on August 1, 1912, and the following quarantine orders were promptly promulgated:

No. 1. White pine blister rust, September 16, 1912.
No. 2. Mediterranean fruit fly, September 18, 1912.
No. 3. Potato wart, September 20, 1912.
No. 4. Gypsy and brown-tail moths, November 5, 1912.

Provisions of the act relative to nursery stock did not become effective until October 1, 1912, after which a system of control was installed. These necessitated a great deal of painstaking work and the complete coöperation and assistance of the Customs and Post Office officials.[35]

Orders and Regulations [36] have been issued, as necessary, to meet the needs of the country. Among the pests thus affected in addition to the four named above are:

Bulb flies, *Merodon equestris* Fabr. and *Eumerus* spp.
Bulb nematode, *Tylenchus dipsaci*
Date palm scales, *Parlatoria blanchardi* and *Phœnicococcus marlatti*
European corn borer, *Pyrausta nubilalis*
Japanese beetle, *Popillia japonica*
Satin moth, *Stilpnotia salicis*

Practically all agricultural products to be used for planting, grafting, or propagating in any manner within the United States are either forbidden or allowed entrance only upon permit under conditions imposed by the Federal Horticultural Board. These

[33] *Ibid.*, vol. 1, p. 886 (1912).
[34] *Jour. Econ. Entom.*, vol. 5, p. 424 (1912).
[35] Marlatt, C. L., *The Federal Plant Quarantine Act*, Jour. Econ. Entom., vol. 6, pp. 133–142 (1913).
[36] Beattie, R. K., *The operation of Quarantine No. 37*, *ibid.*, vol. 14, pp. 201–205 (1921).
Jacobsen, W. C., *The relation of the public's knowledge of insects and their destructiveness to quarantine enforcement*, *ibid.*, vol. 20, pp. 674–678 (1927).

acts have indeed given the protection desired and their inception and enforcement have been a great credit to those charged with so important a duty.

Date Palm Law

This was an act to regulate the distribution of date palms and date palm offshoots and to hold the same in quarantine under the supervision of the state commissioner of horticulture (state department of agriculture) until free from the red date scale (*Phœnicococcus marlatti*) and parlatoria date scale (*Parlatoria blanchardi*) when introduced from or grown in any infested locality within the state, or from other states or foreign countries, after they have been released by the federal horticultural board, and to fix a penalty for the violations of the act. It was approved April 2, 1915 and was intended to prevent the further spread of these two serious date palm pests in California.

Regulation of Transportation of Grapevines for Fuel

This rather unusual law, approved May 16, 1919, was intended to prevent the spread of the grape phylloxera by regulating the transportation within the state, of grapevines or parts thereof taken from localities known to be infested with this pest, and shipped to non-infested areas for fuel. The county horticultural commissioner, in the county where such shipments originated, was empowered to authorize shipment from the premises where grown only upon certification, in writing after inspection, that such grapevines had been thoroughly disinfected under his direction and to his satisfaction. All expenses incurred for the same were to be borne by the owner, agent or person having charge of the grapevines. A penalty for violations of the act was also provided.

Shipment of Injurious Insects

An act to prevent the importation into or transportation through the state of insects injurious to cultivated crops, providing exemption for specific scientific purposes, fixing the authority to grant such exemption and providing a penalty for a violation of the terms of the act, approved May 5, 1917. It was intended to prevent the knowing introduction of all stages of serious insect pests such as the cotton boll weevil and gypsy moth. As an example it might be cited that tourists and travellers were frequently intercepted at the state boundaries with cotton bolls, which they were taking along as souvenirs or curiosities. In these bolls living cotton boll weevils were often found by the inspectors.

Mealybug Law

An act approved June 3, 1921 was for the purpose of preventing the spread of the grape mealybug within the state by

1. Prescribing the boundaries of infested areas.
2. Prescribing rules and regulations to prevent the spread of the same.
3. Prohibiting the moving of grapes, picking boxes, trays or other vineyard appliances from or within any grape mealybug infested district, except in accordance with the rules and regulations of the director of agriculture.

4. Requiring the aid of the county horticultural commissioners in counties where infestations of the grape mealybug occurs.
5. Directing the director of agriculture to make studies necessary to determine most effective methods of controlling the grape mealybug, grape phylloxera, and black mildew.

Capri Fig Law

An act to regulate the packing, shipping and sale of capri figs, vesting the enforcement thereof in the state director of agriculture and the county agricultural commissioners, defining their powers and duties and providing a penalty for violation thereof. Approved April 15, 1927. In effect July 29, 1927.

The statute defines profici crop, mammæ crop, mature pollen, spent figs, and blanks and provides against the sale of capri figs of the profici crop, which do not contain mature pollen, or living adult blastophaga, or which do not contain more than ten per cent of blanks; or the sale of capri figs of the mammæ crop with more than twenty-five per cent spent figs or more than ten per cent blanks.

Walnut Codling Moth

Because of the serious aspects of the attacks of the codling moth on the English walnut in certain sections of southern California an act making an appropriation for the purpose of determining and applying control measures to combat the spread of this pest was approved May 27, 1919. In accordance with the provisions of this act D. B. Mackie of the State Department of Agriculture, made a comprehensive survey of the problem and experiments for the prevention of the spread of the insect which were published in 1919.[37]

As a result of his work an act approved June 3, 1921, was passed which was intended to prevent the distribution and to effect the control of the codling moth of the English walnut by

1. Prescribing boundaries of infested areas.
2. Prescribing rules and regulations governing the treatment of walnut sacks, trays or other orchard appliances likely to carry the pest into non-infested areas.
3. Providing a penalty for failure to comply with the law.

Since the passage of the act, however, the codling moth has become so generally distributed throughout the walnut growing sections of the state as to make the provisions of the law available in comparatively small areas. The work of control, however, has proven very satisfactory and the needs for legislation are not now as urgent as when the law was passed in 1921.

Forest Insect Control

An act (3704), declaring insect pests, insect infestations and pine beetles to be a nuisance, and providing for the control, eradication and destruction of said insect pests, was approved May 2, 1923 and provided as follows:

1. Pine beetles and other destructive insect forest pests declared to be a public nuisance.
2. Owners of timber required to control, destroy or eradicate such insect pests as provided for by law.

[37] Calif. State Dept. Agr., *Mthly. Bul.*, vol. 8, pp. 250–256, figs. 115–117 (1919).

3. State Forester authorized to investigate infestations of forest insects and
   (1) Declare district or zone of infestation with approval of State Board of Forestry.
   (2) Upon written application of the owners of sixty per cent or more of the timber within said infested district, requesting the abatement of the nuisance, the State Forester shall notify all owners to destroy or eradicate said pests.
4. If after thirty days, the owners fail to comply with request, then the State Forester shall proceed in such manner as approved by the State Board of Forestry.
5. Expenses of said work done by the State Forester shall become a lien upon the property and collected by due process of law.
6. Owners proceeding in good faith to control pests shall be exempt from interference.
7. State Board of Forestry may dissolve districts or zones whenever control work is considered no longer feasible.
8. Members of a coöperative association of timberlands which are engaged in the control of eradication of said insect pests and pine beetles, using methods approved by State Board of Forestry, are exempt from the provisions of the act.
9. "For the purposes of this act any land shall be considered timberland which has enough timber, standing or down, to constitute, in the judgment of the State Board of Forestry, an insect or pine beetle infestation breeding ground of a nature to constitute a menace, injurious and dangerous to timber or forest growth in the district or zone under consideration."

Legislation Relating to Insects and Public Health in California

The state board of health and local boards of health and health officers in California were provided for in the State Constitution in 1879. (Article xx, no. 14, Art. xi, no. 11.) The political code was amended in 1905 to provide that the state board of health consist of seven licensed and practicing physicians of the state, appointed by the governor for a term of four years. Among the sanitary regulations, the reporting of diseases and other matters relating to health, insects and ticks are included in many instances. The department of public health, and the state board of public health were created by an act (Chapter 276) approved April 29, 1927. Among the tick and insect borne diseases that each coroner, and every county, city, or town health officer is required to report at once in writing to the secretary of the state board of health in Sacramento are: plague, yellow fever, malaria, typhus fever, dengue, pellagra, Rocky Mountain spotted fever.

Special acts relating to insects are:

Extermination of rodents

An act approved March 13, 1909, provides for the extermination of rats, mice, gophers and ground squirrels. This act was amended (Chapter 378)

May 9, 1927 and was aimed at the extermination of pneumonic plague and involved the rodent-infesting fleas, the direct carriers of plague from rodents to man.

Contagious and infectious diseases

An act approved June 7, 1913, provides for the extermination of "rodents, insects and other vermin which are liable to convey or spread contagious or infectious disease from an existing focus declared by the state board of health" in the same general manner as in the case of injurious orchard pests.

Mosquito abatement districts

The act relating to mosquito abatement districts, approved May 29, 1915, provides for the following:

I. The organization, incorporation and management of mosquito abatement districts
   1. By any county, city and county or portion thereof having a population of not less than one hundred inhabitants.
      (1) By a petition to board of supervisors, or governing body of a municipality, signed by at least ten per cent of voters in district to be formed.
         a. Describing boundaries of proposed district.
         b. Text of petition published in a newspaper in county or municipality at least two weeks prior to the presentation of said petition—in absence of a newspaper to be posted for same length of time in three public places within the proposed district.
         c. Also notices of hearings to be published or posted with text of petition. All persons interested may appear and be heard.
         d. Hearings before board of supervisors who may declare the creation of such mosquito abatement district.
   2. By county clerk filing certified copy of order creating district.
   3. Appointment of board of trustees, consisting of five or less members appointed by board of supervisors or governing body of a municipality or by both; trustees to hold office for two years.
   4. Meetings of board of trustees.
   5. Powers and duties of the board of trustees.
      (1) To take all necessary and proper steps for the extermination of mosquitoes, flies or other insects within the district and to abate as nuisances all stagnant pools of water and other breeding places for mosquitoes, flies or other insects within the district.
      (2) To purchase necessary materials and employ labor.
      (3) To build, repair and maintain necessary levees, cuts, canals, or channels upon any land within the district and to acquire by purchase, or by other lawful means, any necessary lands, rights of way, easements, property or material necessary for such purposes.

(4) To indemnify or compensate any owner of land for any injury or damages caused by the carrying out of the provisions of the act.

6. Estimate the amount of taxes necessary to be levied by the board of supervisors for the maintenance of said district. Said mosquito abatement district tax to be made an additional tax upon all taxable property in the district and to be collected with the regular taxes of said district.
7. To annex adjacent and contiguous territory by a process of petition and election by residents of the proposed annexed territory.
8. Dissolution of the district by a two-thirds vote of the electors of said district. Said election to be called by the board of trustees.
9. Publication of required notices.

This act was amended (Chapter 256) April 27, 1927 and the following provisions added:

I. All breeding places for mosquitoes caused by any artificial change in the natural conditions thereof, are expressly declared to be a public nuisance and said nuisance may be abated by a process of law similar to that pertaining to the control of plant-infesting insect pests.[38]

Hotel sanitation and bedbugs

In the hotel sanitation act, approved May 11, 1917, it is specified that "any room in any hotel in this state which is or shall be infected with vermin or bedbugs or similar things, shall be thoroughly fumigated, disinfected and renovated until such vermin or budbugs or other similar things are entirely exterminated."

Typhus fever and the body louse

During the months of June, July, August, and September, 1916, twenty-six cases of typhus fever, resulting in three deaths, were discovered among the Mexican laborers, recently arrived in southern California from Mexico.[39] A survey of the Mexican labor camps showed the body louse to be present upon a large percentage of the men in the railroad camps, especially upon the recent arrivals. In order to prevent the spread and further introduction of the typhus fever in the state the California State Board of Health issued regulations to all railroad companies "that they must instruct the foremen of their section gangs (1) to carry out the regulations for delousing, sanitation and reporting illness; and (2) to supervise a repetition of a compliance therewith by every man, woman and child in the camp every seven days, and the foreman shall report thereon once a week." [40]

In October, 1916, further regulations and rules were adopted to insure the public safety. [41]

[38] *Mosquito and malaria control*, Calif. State Dept. of Public Health, Bul. 44, 41 pp., 20 figs. (1927).

[39] Cumming, J. G., Calif. State Bd. Health, *Mthly. Bul.*, vol. 12, p. 202 (1916).

[40] *Ibid.*, vol. 12, p. 203 (1916).

[41] *Ibid.*, vol. 12, pp. 186–189 (1916).

CHAPTER IX

BIOGRAPHY

It was my original purpose to include in this chapter a short biographical sketch of everyone who had contributed to the development of entomology in California and it is a real disappointment to me not to be able to carry out my plans. Much valuable material was collected which I hope to be able to use at some future time. It is difficult to realize the enormous amount of space required to adequately cover the field. In the process of selection it was decided to include sketches of: (1) some of the great founders of entomology whose influences are world-wide; (2) the fathers of entomology in North America, who established the science in this country and who described many western insects; and (3) the pioneer collectors, investigators, and teachers, who at sometime worked within the confines of the state or described material taken here. Among all of these groups there are many important names that might also have appeared, and some of my readers will no doubt wonder at these omissions in view of the fact that a number of apparently obscure names are included. To my mind it is important at this time to write into history those names of worthy individuals, who, otherwise, are likely to be forgotten altogether. Even now it has been most difficult to gather authentic information regarding some of them. Of those entomologists still living, only a few of the outstanding names are included. My chief regret has been the exclusion of all others!

Ashmead, William Harris [1] (Fig. 157). Born at Philadelphia, Pennsylvania, September, 19, 1855; died at St. Elizabeth's Hospital, Washington, D. C., October 17, 1908. Leading authority on Parasitic Hymenoptera in North America. Educated in public and

[1] Howard, L. O., *Proc. Entom. Soc. Wash.*, vol. 10, pp. 128–156, portrait (1908); *Proc. Wash. Acad. Sci.*, vol. 10, pp. 187–189 (1908); *Jour. Econ. Entom.*, vol. 1, pp. 409–410 (1908).
Ent. News, vol. 19, pp. 397–398, portrait (1908).
Bethune, C. J. S., *Can. Entom.*, vol. 40, pp. 437–438 (1908); Entom. Soc. Ontario, *39th Ann. Rept.*, p. 150 (1908).
Smith, J. B., *Pop. Sci. Mthly.*, vol. 76, p. 473 (1910).
Wade, J. S., *Ann. Entom. Soc. Am.*, vol. 21, p. 492 (1928).

private schools of his native city, he early entered the publishing house of J. B. Lippincott Co. Later he went to Florida to establish a printing house for agricultural literature. Here he founded the Florida Dispatch, an agricultural weekly in which he edited the scientific portion, devoting most of his time to injurious insects. In 1879 he began contributing papers to scientific journals and in 1887 was appointed special field entomologist in the Division of Entomology, U. S. Dept. of Agriculture, in Florida. The next year he became entomologist to the State Agricultural College and Experiment Station at Lake City, Florida. He returned to the Division of Entomology as assistant entomologist and investigator in 1889. The next year, 1890–1891, he went abroad and studied in Berlin and elsewhere returning to the same work in 1891. In 1895 he became Assistant Curator of the Division of Insects in the U. S. National Museum, which position he retained until his death. He received the degree of M. S. from the Florida State Agricultural College and the degree of Ph. D. from the Western University of Pennsylvania in 1904.[2]

FIG. 157.—William Harris Ashmead (1855–1908) was one of the foremost authorities of the Parasitic Hymenoptera in America and the world. (From Proc. Entom. Soc. Wash., 1908.)

His activities have been divided into seven overlapping periods as follows:

1. Early, mostly economic work 1879–1887.
2. Interest in Hemiptera and Coleoptera 1881–1886.
3. Interest in Cynipidæ 1881–1903.
4. Descriptive papers on various groups of Hymenoptera 1881–1906.
5. Monograph of the Proctotrypidæ 1893–1903.

[2] The thesis submitted in partial fulfillment for this degree was the Classification of the Chalcid flies of the superfamily Chalcidoidea, with descriptions of new species in the Carnegie Museum, collected in South America by Herbert H. Smith. *Memoirs Carnegie Mus.*, vol. 1, no. 4, pp. i–xi, 225–551, pls. xxxi–xxxix (1904).

6. Classification of the superfamilies of Hymenoptera 1902–1906.
7. Descriptions of foreign insects 1903–1906.

He was primarily a systematist but published extensively in many fields of entomology. Crawford [3] credits him with 260 papers—the first entitled, On a Mite Preying on the Orange Scale Insect, appeared in Canadian Entomologist, vol. 11, pp. 93–94 (1879) and the last, A New Cryptine Genus from Cuba, *ibid.*, vol. 38, pp. 294–295 (1906).

The most important papers are:

Orange insects: A treatise on the injurious and beneficial insects found on orange trees in Florida (Jacksonville, Fla., 1880), xv + 78 pp., iv pls.

A monograph of the N. Am. Proctotrypidæ, U. S. Nat. Mus., Bul. 45, 472 pp., 18 pls. (1893).

Classification of the entomophilous wasps, or the superfamily Sphegoidea, Can. Entom., vol. 31, pp. 145–155, 161–174, 212–225, 238–251, 291–300, 322–330, 345–357 (1899).

Classification of the fossorial, predaceous and parasitic wasps, or the superfamily Vespoidea, ibid., vol. 32, pp. 145–155, 185–188, 295–296 (1900); vol. 34, pp. 79–88, 130–137, 163–166, 203–210, 219–231, 268–273, 287–291 (1902); vol. 35, pp. 3–8, 39–44, 95–107, 155–158, 199–205, 303–310, 323–332 (1903); vol. 36, pp. 5–9 (1904).

Classification of the pointed-tailed wasps, or the superfamily Proctotrypoidea, Jour. N. Y. Entom. Soc., vol. 10, pp. 240–247 (1902); vol. 11, pp. 28–35, 86–99 (1903).

Classification of the gall-wasps and the parasitic cynipoids, or the superfamily Cynipoidea, Psyche, vol. 10, pp. 7–13, 59–73, 140–155, 210–216 (1903).

Classification of the chalcid flies, or the superfamily Chalcidoidea, with descriptions of new species in the Carnegie Museum, collected in South America by Herbert H. Smith, Carnegie Mus., Memoirs, vol. I, no. 4, pp. i–xi+225–551, pls. xxxi–xxxix (1904).

Some mites and insects of interest which were named by Ashmead:

Rust or silver mite, *Phyllocoptes oleivorus* (Ashm.).
Garden flea hopper, *Halticus citri* (Ashm.).
Opius dimidiatus (Ashm.).
Microbracon xanthonotus (Ashm.).
Diæretus chenopodiaphidis (Ashm.).
Aphidius confusus Ashm.
Eremotylus arctiæ Ashm.
Ant-like gallfly, *Andricus lasius* (Ashm.).
Diplolepis politus (Ashm.).
Heterœcus dasydactyli (Ashm.).
Plagiotrochus chrysolepidicola (Ashm.).

[3] Crawford, J. C., *Proc. Entom. Soc. Wash.*, vol. 10, pp. 131–148 (1908).

Dryophanta douglasi (Ashm.).
Xystus xanthopsis (Ashm.).
Polynema howardi (Ashm.).
Anagrus armatus (Ashm.).
Tetrastichus blepyri Ashm.
californicus Ashm.
Hyperteles lividus (Ashm.).
Pleurotropis albitarsis Ashm.
Entedon bigeloviæ Ashm.
Diaulinus begini (Ashm.).
Habrocytus languriæ Ashm.
Pachyneuron siphonophoræ (Ashm.).
Urolepis rufipes Ashm.
Ablerus clisiocampæ (Ashm.).
Aphidencyrtus aphidiphagus (Ashm.).
Anisotylus similis Ashm.
Chalcaspis phenacocci (Ashm.).
Signiphora aleyrodis Ashm.
Yellow-cloaked chalcid, *Signiphora flavopalliata* Ashm.
Signiphora mexicana Ashm.
Thysanus nigra (Ashm.).
Syntomaspis californica Ashm.
Trissolcus euschisti Ashm.
Isobrachium myrmecophilum Ashm.
Gonatopus californicus Ashm.

Baker, Charles Fuller [4] (Fig. 158). Born at Lansing, Michigan, March 22, 1872; died at Manila, P. I., July 22, [5] 1927. Entomologist, botanist, agronomist, collector, teacher, agricultural director and dean. He graduated from the Michigan Agricultural College in 1892 and in the same year became an assistant to C. P. Gillette at the Colorado Agricultural College, Fort Collins, Colorado. Here he made very extensive botanical and entomological collections and began publishing. One of his first important contributions was

[4] Cook. A. J., Calif. Hort. Com., *Mthly. Bul.*, vol. 1, pp. 381–382 (1912).
Welles, C. G., *Science*, n. s., vol. 66, pp. 229–230 (1927).
Manila Bulletin, vol. 71, pp. 1, 6 (July 23, 1927).
Science, n. s., vol. 66, p. 505 (1927); vol. 69, suppl., p. xii (1929).
Calvert, P. P., *Entom. News*, vol. 38, pp. 261–262 (1927).
Hoffman, W. E., *Lingnaam Agr. Rev.* (Canton, China), vol. 4, no. 2, pp. 197–202, portrait, pl. xviii (Oct., 1927).
Essig, E. O., *Jour. Econ. Entom.*, vol. 20, pp. 748–754, portrait (1927); *Philippine Jour. Sci.*, vol. 35, pp. 429–436, 2 portraits (1928); *Pomona College Quart. Mag.*, vol. 16, pp. 175–179 (1928).
Cole, F. R., *Pomona College Quart. Mag.*, vol. 16, pp. 172–175 (1928).
Yule, E. S., et al., *Philippine Agr.*, vol. 16, special number, 82 pp., 2 portraits, 5 figs. (1928).
Wade, J. S., *Ann. Entom. Soc. Am.*, vol. 21, p. 493 (1928).
[5] First reports stated that he died on July 21.

A Preliminary List of the Hemiptera of Colorado [6] in co-authorship with C. P. Gillette. It was in this publication that he described the beet leafhopper, *Eutettix tenellus*, as *Thammotettix*.[7] Most of his earlier papers dealt with the Homoptera and particularly the Cicadellidæ. In 1893 he was in charge of the Colorado forestry and zoölogical exhibit of the Columbian Exposition at Chicago. The years 1897–1899 were spent partly in Alabama, where he acted as zoölogist in the Alabama Polytechnic Institute, and entomologist at the Agricultural Experiment Station. Here he was connected with the Alabama Biological Survey. During 1898–1899, he was botanist on the H. H. Smith [8] exploring expedition in the Santa Marta Mountains, Colombia. In 1899–1901 he was a teacher of biology in the Central High School at St. Louis, Missouri. Following this he studied with Vernon L. Kellogg at Stanford University, California, where he obtained the degree of Master of Science in 1903.

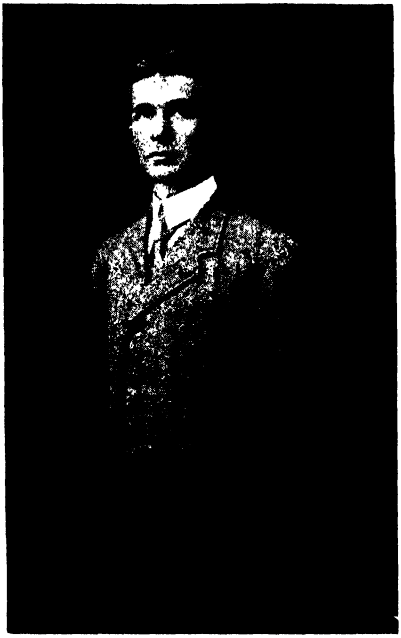

FIG. 158.—Charles Fuller Baker (1872–1927) was an entomologist with an untiring capacity and was an inspiring teacher. His enormous collection of Philippine and Malayan insects is at the U. S. National Museum. (Photograph taken at Los Angeles in 1909, when he was a teacher at Pomona College.)

Through the efforts of A. J. Cook, Baker was induced to accept the position of Assistant Professor of Biology at Pomona College in 1903, but he remained there only one year. During this year he began the publication of Invertebrata Pacifica.[9]

[6] *Bul. no. 31*, Tech. Ser. no. 1, Colo. Agr. Expt. Sta., Ft. Collins, Colo., 137 pp. (1895).

[7] The generic position of this insect is still questioned by systematists.

[8] Celebrated entomological explorer and collector.

[9] This serial appeared as follows: *Homoptera*, vol. 1, pp. 1–12 (Sept. 15, 1903). *Orthoptera*, pp. 13–16 (Nov. 30, 1903); *Diptera*, pp. 14–17 (Feb. 10, 1904); *Hymenoptera*, pp. 41–70 (Aug. 26, 1904); *Orthoptera*, pp. 71–84 (Jan. 30, 1905); *Neuropteroid*

He left California to become Chief of the Department of Botany of the Cuban Experiment Station (Estación Agronómica), Santiago de las Vegas, Cuba, which position he held from 1904 until 1907. From Cuba he went to Brazil to assume the position as Curator of the Herbarium and Botanical Garden, Museu Gœldi at Para, where he stayed one year. In Brazil he amassed very large collections of both plants and insects which were presented to Pomona College upon his return there in 1908. Here he proved himself to be a most successful teacher and had a profound influence upon his students. For the citrus fruit growers of the region a system of orchard inspection was organized which gave not only excellent field experiences, but remunerative employment for advanced students, and rich returns to the growers.

Early in 1909 he explained to Cook the great need of serial publications, not only as an outlet for the work of students and specialists, but also for the benefit of all interested in the biological sciences, especially entomology and botany. Cook at once agreed and undertook, single-handed, to raise sufficient money by private subscription to finance first a Journal of Entomology [10] and then a Journal of Economic Botany.[11] The former appeared in March, 1909, and the latter in February, 1911. Another notable contribution was the publication of the First Annual Report of the Laguna Marine Laboratory [12] in 1912. The Pomona College marine station at Laguna Beach was organized almost entirely through the efforts of Cook and Baker with financial assistance from a few local residents, and it is still ably conducted by Hilton.

In October, 1911, the appointment of Cook as Horticultural

Insects, pp. 85–92 (May 15, 1905); *Hymenoptera*, pp. 93–110 (Aug. 20, 1905); pp. 111–132 (Oct. 27, 1905); *Heteroptera*, pp. 133–140 (Jan. 24, 1906); *Hymenoptera*, pp. 141–159 (May 24, 1906); pp. 161–178 (Feb. 28, 1907); pp. 179–198 (Oct. 8, 1907). It was begun at Claremont, Calif., and completed (pp. 71–198) during his stay at Santiago de las Vegas, Cuba. It contained descriptions of insects which he collected personally, mostly in California and Nevada. A part of his insect collection containing types and paratypes of many of these is at Pomona College along with many exotics collected in Cuba and Brazil.

[10] Baker edited vols. 1 (1909) through no. 2, vol. 4 (1912). When W. A. Hilton succeeded as head of the department of biology and editor of the scientific journals he changed the name to *Journal of Entomology and Zoölogy*, beginning with vol. 5 (1913).

[11] *The Journal of Economic Botany* edited by Baker continued through three volumes, 1 (1911); 2 (1912); 3 (1913). Its discontinuance was announced in nos. 3 and 4, vol. 3 (Dec., 1914) by D. L. Crawford, then Professor of Botany at Pomona College.

[12] Published by the Department of Biology, Pomona College, Claremont, Calif., 218 pp., 130 figs. (1912).

Commissioner of California so disturbed the activities of the Biology Department at Pomona that Baker decided to accept the position of Professor of Agronomy at the University of the Philippines which was offered him by his good friend, Dean E. B. Copeland, whom he succeeded in 1918. During his long stay in the Philippines he left only once and that was on a year's leave of absence in 1917–1918 to become assistant director of the botanical gardens at Singapore. Every ounce of vitality was poured into his work. His entomological collections received the greater part of his spare time. He maintained at his own expense a Cuban collector named Julian Hernandez whom he carefully trained and kept with him after he left Cuba in 1907. This man spent all of his time either collecting or caring for the insects, or in the domestic duties of a bachelor's household. Botany came in for a share also and fungi in particular were taken extensively throughout the Archipelago. Every cent of his salary that could be utilized went towards building up the collection.

Failing health and gradual replacement of American teachers and investigators by Filipinos many times influenced him to desire to give up his position in the Philippines and seek a place of complete change and a haven of peace and quiet in America where he could find space to house and work on this large insect collection during the remaining years of his life. To this end an attempt was made to secure for him a place at the California Academy of Sciences, but the difficulty of raising a proper endowment indefinitely delayed action until it was too late.

For several years he was considering an offer from a strong combination of all the entomological interests of the Hawaiian Islands to conduct extensive work in the western Pacific Islands,—"Over Wallace's Trail." His failure to negotiate terms in California and the opportunities offered by his former student, President Crawford, of the University of Hawaii, led him finally to accept the Hawaiian offer. Accordingly he presented his resignation to the College of Agriculture, University of the Philippines, Los Banos, Laguna, P. I., to take effect in November, 1927. On June 9, 1927, the Board of Regents of the University of the Philippines passed a resolution appointing him Professor of Tropical Agriculture and Dean Emeritus of the College of Agriculture of the University of the Philippines, and also Director Emeritus of the Experiment Station, effective December 1, 1927. His untimely

death came before this much earned public recognition was realized.

His insect collection is a remarkable achievement amassed over a period of fourteen years of unremitted labor. From reports received from Baker in 1926 it contained approximately four hundred thousand pinned, and half as many unmounted specimens. On November 9, 1926, he wrote me concerning it: "The collection is undoubtedly the largest existing private collection covering extreme Western Pacific. The pinned part of it is contained in one thousand five hundred cases, all crowded full. But as much more has been placed in the hands of one hundred ten (later one hundred fifteen) specialists [13] and considerable portions of the latter will be returned. I believe it is one of the most important collections *basic* to either Central and South Pacific work or to Southwest Asian studies since it includes several thousand types and cotypes. Moreover, more material is constantly coming in and I have so arranged it that continued collections on a large scale will be made after I leave here. I also have a lot of fine Australian material constantly coming in. Moreover, I have taken the fullest advantage of exchange possibilities, making important exchanges with European museums and with individuals, in this way securing a vast number of species I lacked, many of these being cotypes." All of the mounting, labeling, packing and shipping to specialists was done by Baker himself at night; the entire work including the salary of the collector already referred to, cost of pins, boxes, labels, packing and postage was supported by his modest salary, yet, as he states, "if one lives simply and rigorously as a Trappist monk, many things may be possible." According to his long standing will, the main insect collection was bequeathed to the U. S. National Museum, and his plant collection, to the University of the Philippines.

[13] Some of the specialists who were supplied with entomological material by Baker are: Coleoptera—Hans Gebien, R. Kleine, and A. Zimmermann, Germany; A. Boucomont, Ed. Fleutiaux, A. Gronvelle, and M. Pic, France; Jan Obenberger, Czechoslovakia; H. Krekich-Strassoldo, Austria; Chr. Aurivillius, Sweden; H. E. Andrewes and Guy A. K. Marshall, England; Edward A. Chapin, United States. Orthoptera—Achille Griffini, Italy; H. H. Karny, Dutch East Indies; A. N. Caudell, United States. Homoptera—Frederick Muir and D. L. Crawford, Hawaii; L. Melichar, Moravia; W. D. Funkhouser and T. D. A. Cockerell, United States. Hemiptera—W. L. McAtee and J. R. Malloch, United States. Diptera—P. Sack, Germany; W. S. Patton, Scotland; M. Bezzi, Italy; J. R. Malloch and G. F. Ferris, United States. Hymenoptera—E. A. Elliott, England; H. L. Viereck, Canada; T. D. A. Cockerell, United States. Baker worked chiefly in Homoptera on the Jassoidea, Fulgoridæ and Cercopidæ, and in the Hymenoptera on the parasitic Braconidæ, during his stay in the Philippines.

Entomology and mycology were only side issues or hobbies; his real work was the development of agriculture in the Philippines. A perusal of files of the Philippine Journal of Science [14] and more particularly the Philippine Agriculturist and Philippine Agricultural Review, the last two of which he was an associate editor, will give something of the results accomplished. Concerning this broader work the following editorial of The Tribune [15] is pertinent: "The Baker Leadership! The University of the Philippines can ill afford to lose the services of Dean Charles F. Baker of the College of Agriculture. He has made of his college an institution of the highest standing in this country and one to which recognition abroad has been deservedly given. The Los Banos unit of the University (is) what it is because Dean Baker has put in its organization and management much of his own forceful personality and transferred to the faculty his own enthusiasm for its mission.

"The work of bringing advance methods of agricultural practices to the people on the farms has only been started. It is the work not for a decade but for a generation. In this task Dean Baker has been easily a recognized leader. It is not too much to say that, were he to leave the college permanently, the Baker leadership will yet be felt through years to come. It is a measure of his success that what is often good in scientific agriculture may be traced to a Baker tradition."

In 1929 the Board of Regents of the University of the Philippines established a Baker Memorial Professorship in the College of Agriculture. This professorship, which is in memory of Charles Fuller Baker, provides for the services in the College of a man from abroad who shall be in residence in the College eight months at least and shall carry a teaching load of five hours a week. " It is the purpose to secure men who are specialists in the different sciences allied to agriculture. This professorship in honoring Dean Baker provides for incalculable benefit to the College which in itself is a fitting tribute to a man whose services to the College were so valuable."

Baker was a member of the American Association for the Advancement of Science, American Association of Economic Entomologists, Entomological Society of America, Washington Entomological Society, Southern California Academy of Sciences, and the Havana Academy.

[14] In this journal were published the results of much of the entomological work done by Baker and his large corps of specialists to whom he forwarded his material.

[15] *Independent Filipino Daily*, Carlos P. Romulo, editor, Manila, P. I., p. 4 (Nov. 6, 1926).

Although he died comparatively young, he did the life work of many men.

Some of the important insects which were named by Baker are:

Blue sharpshooter, *Cicadella circellata* (Baker).
Beet leafhopper, *Eutettix tenellus* (Baker).
Ploiariopsis reticulata Baker.
Barce banksi Baker.
Ceratophyllus acutus Baker.
californicus Baker.
ignotus Baker.
montanus Baker.
sexdentatus Baker.
Hoplopsyllus anomalus (Baker).
Apanteles gillettei Baker.
ephestiæ Baker.

The clover aphis, *Anuraphis bakeri* (Cowen), is probably the most important insect named for him. Casey named three California beetles after him and Fall, one. There are bearing his name innumerable insects taken from many parts of the world.

In addition to the foregoing citations the following publications by him should be mentioned:

A revision of American Siphonaptera or fleas, together with a complete list and bibliography of the group, Proc. U. S. Nat. Mus., vol. 27, pp. 365–469, pls. x–xxvi (1904).

The classification of the American Siphonaptera, *ibid.*, vol. 29, pp. 121–170 (1906).

A study of caprification in Ficus nota, Philip. Jour. Sci., vol. 8, pp. 63–83, figs. 1–4 (1913).

Ichneumonoid parasites of the Philippines, I, Rhogadinæ (*Braconidæ*), I, *ibid.*, vol. 12, pp. 281–327 (1917); II, *ibid.*, pp. 383–422 (1917).

The genus Krisna (*Jassidæ*), *ibid.*, vol. 15, pp. 209–220, pls. i–v (1919).

The Malayan Machærotinæ (*Cercopidæ*), *ibid.*, vol. 15, pp. 67–80, pls. i–iii (1919).

The Jassoidea related to the Stenocotidæ with special reference to Malayan species, *ibid.*, vol. 23, pp. 345–405, pls. 1–5 (1923).

The genus Makilingia (*Jassoidea*) *in the Philippines*, *ibid.*, vol. 24, pp. 57–71, pls. 1–2 (1924).

Some Lophopidæ (*Fulgoridæ*) *of the Indo-Malayan and Papuan Regions*, *Treubia*, vol. 6, pp. 271–296, pls. ii–viii (1925).

Remarks on certain Indo-Malayan Fulgora, with special reference to Philippine species, Philip. Jour. Sci., vol. 28, pp. 343–364, pls. 1–10 (1925).

Braconidæ-Cheloninæ of the Philippines, Malay and Australia, I, Chelonini (*Except* Chelonus), *ibid.*, vol. 31, pp. 454–489 (1926).

Banks, Nathan. Born at Roslyn, New York, April 13, 1868; at present curator of insects, and associate professor of zoölogy, Museum of Comparative Zoölogy, Harvard University, Cambridge, Massachusetts. Banks has long been a leading American authority on the arachnids, neuropteroid groups, certain families of Diptera, Hymenoptera, and Hemiptera, as well as on geographical distribution and entomological bibliography. He graduated from Cornell University in 1889 and received the M. S. degree from the same institution in 1890. He immediately became associated with the Division of Entomology, U. S. Dept. of Agriculture, as agent, 1890–1892, assistant entomologist, 1896–1916. In 1916 he accepted the position at Harvard which he now holds following H. A. Hagen and Samuel Henshaw.

Banks has had a great influence upon the development of systematic entomology in America and has named large series of species in more orders than any other living American entomologist. His contributions to western entomology are very great, and his name is familiar to all who study arachnids and insects.

It is impossible here to list all of his published contributions and the author will only attempt to give some of the most important ones.

Scorpions of California, P. C. Jour. Entom., vol. 2, pp. 185–190 (1910).

Pseudoscorpionida of California, *ibid.*, vol. 3, pp. 633–640 (1911).

Phalanginæ, Can. Entom., vol. 25, pp. 205–211 (1893).

Phalangida Mecostethi of United States, Trans. Am. Entom. Soc., vol. 20, pp. 149–152 (1893).

Scorpions, Solpugids, and Pedipalpi, Am. Naturalist, vol. 34, pp. 421–427 (1900).

Ixodoidea of the United States, U. S. Dept. Agr., Div. Entom., Bul. 15, Tech. Ser., 60 pp., 10 pls. (1908).

Some new N. Am. Acarina, Trans. Am. Entom. Soc., vol. 21, pp. 209–222 (1894).

Red spiders of the United States, U. S. Dept. Agr., Div. Entom., Bul. 8, Tech. Ser., pp. 65–77 (1900).

A treatise on Acarina, or mites, U. S. Nat. Mus., Proc., vol. 28, pp. 1–109 (1904).

A revision of the Tyroglyphidæ of the United States, U. S. Dept. Agr., Div. Entom., Tech. Ser., Bul. 13, 34 pp., 6 pls. (1906).

Catalogue of the Acarina, U. S. Nat. Mus., Proc., vol. 32, pp. 595–625 (1907).

The Acarina, or mites, U. S. Dept. Agr., Rept. 108, 153 pp., 294 figs. (1915).

Catalogue of the Neuropteroid insects (Except Odonata) of the U. S., Am. Entom. Soc., 53 pp. (1907).

A synopsis, catalogue and bibliography of the Neuropteroid insects of Tem-

perate N. Am., Trans. Am. Entom. Soc., vol. 19, pp. 327–373 (1892); vol. 22, pp. 313–316 (1895).

Desc. of new Nearctic Neuropteroid insects, ibid., vol. 32, pp. 1–51, 5 pls. (1906); vol. 34, pp. 255–267, pls. xvii–xix (1908).

Some new Neuropteroid insects, Jour. N. Y. Entom. Soc., vol. 11, pp. 236–243, figs. 1–2 (1903); vol. 15, pp. 162–166, figs. 1–5 (1907).

Descriptions of new species of N. Am. Neuropteroid insects, Trans. Am. Entom. Soc., vol. 22, pp. 313–316 (1895); vol. 24, pp. 21–31 (1897); vol. 25, pp. 199–218 (1898); vol. 26, pp. 240–259 (1899–1900); vol. 30, pp. 97–110, pl. I (1904); vol. 37, pp. 335–360, pls. xi–xiii (1911).

A revision of Nearctic Chrysopidæ, ibid., vol. 29, pp. 137–162, pl. II (1903).

A revision of the Nearctic Coniopterygidæ, Proc. Entom. Soc., Wash., vol. 8, pp. 77–86, pls. vi–vii (1906).

The genus Brachynemurus, Entom. News, vol. 24, pp. 63–65 (1913).

American Trichoptera, Can. Entom., vol. 46, pp. 149–156, pls. viii–x; pp. 201–205, pl. xv; pp. 252–258, pl. xx; pp. 261–268 (1914).

Revision of Nearctic termites, U. S. Nat. Mus., Bul. 108, 228 pp., 70 figs., 33 pls. (1920) (with Snyder, T. E.).

New Neuropteroid insects, Bul. Mus. Comp. Zoöl., vol. 62, no. 1, 22 pp., 2 pls. (1918); vol. 64, no. 3, pp. 299–362, 7 pls. (1920); vol. 65, pp. 421–455, 4 pls. (1924).

Revision of the Nearctic Myrmeleonidæ, ibid., vol. 68, no. 1, 84 pp., 4 pls. (1927).

Catalogue of the Nearctic Hemiptera-Heteroptera (Philadelphia, 1910).

Notes on species of Emesidæ, Psyche, vol. 16, pp. 43–48, figs. 1–2 (1909).

The structure of certain dipterous larvæ with particular reference to those in human foods, U. S. Dept. Agr., Bur. Entom., Tech. Ser. 22, 44 pp., 8 pls. (1912).

Synopsis of the genus Dasyllis, Bul. Brooklyn Entom. Soc., vol. 12, pp. 52–64 (1917).

Synopses of Zodion and Myopa, Ann. Entom. Soc. Amer., vol. 9, pp. 191–250 (1916).

New fossorial Hymenoptera, Bul. Mus. Comp. Zoöl., vol. 61, no. 5, pp. 97–115 (1917).

The Psammocharidæ of Western North America, ibid., vol. 63, no. 5, pp. 229–248 (1919).

Principal insects liable to be distributed on nursery stock, U. S. Dept. Agr., Div. Entom., Bul. 34, n. s., 46 pp., 43 figs. (1902).

Bibliography of Economic Entomology, ibid., vol. 6, pp. 1–273 (1898); vol. 7, pp. 1–113 (1901); vol. 8, pp. 1–132 (1905).

List of works on N. Am. Entomology, ibid., Bul. 24, 95 pp. (1900); Bul. 81, n. s., 120 pp. (1910).

Directions for collecting and preserving insects, U. S. Nat. Mus., Bul. 67, pp. 1–135 (1909).

Index to literature of Economic Entomology, Am. Assoc. Econ. Entom., Spec. Pub. 1, 323 pp. (1907).

Banks has brought together one of the largest collections of Arachnida and insects in America. The former contains no less

than 6,000 specimens and the latter about 70,000 specimens. Among the insects the most valuable part is the Neuroptera, which includes about 12,000 specimens from all parts of the world. This collection is now in the Museum of Comparative Zoölogy, Cambridge, Mass.

Banks has named many spiders, scorpions, solpugids, ticks, mites, and neuropterous, dipterous, and hymenopterous insects. A few of the large list are:

Slender-clawed scorpion, *Tityus tenuimanus* Banks.
Hairy-tail scorpion, *Vejovis hirsuticauda* Banks.
Eremobates putnami Banks.
Hemerotrecha californica Banks.
Ammotrecha californica (Banks).
Pratt's tick, *Ixodes æqualis* Banks.
Rocky Mountain spotted fever tick, *Dermacentor venustus* Banks.
Margined tick, *Dermacentor parumapertus marginatus* Banks.
Green wheat mite, *Notophallus viridis* Banks.
Red snout mite, *Bdella utilis* Banks.
Whirligig mite, *Anystis agilis* Banks.
Jumping mite, *Tetranobia longipes* (Banks).
Cardinal mite, *Tenuipalpus cardinalis* Banks.
Date mite, *Paratetranychus simplex* (Banks).
Red orchard mite, *Erythræus posticatus* Banks.
Pacific red mite, *Trombidium pacificum* Banks.
Cyclamen mite, *Tarsonemus pallidus* Banks.
Peach silver mite, *Phyllocoptes cornutus* Banks.
Hubbard's termite, *Kalotermes hubbardi* Banks.
Western termite, *Reticulitermes hesperus* Banks.
Black-legged termite, *Reticulitermes tibialis* Banks.
California termite, *Amitermes californicus* Banks.
California embiid, *Embia californica* Banks.
Ten-spotted psocid, *Peripsocus californicus* Banks.[16]
Occult raphidia, *Raphidia occulta* Banks.
Mantispa brevicollis Banks.
Lomamyia texana Banks.
Boriomyia disjuncta Banks.
Pacific brown lacewing, *Hemerobius pacificus* Banks.
Slender brown lacewing, *Sympherobius angustus* (Banks).
Chrysopa majuscula Banks.
Narrow dusty wing, *Coniopteryx angustus* Banks.
Hagen's dusty wing, *Conwentzia hageni* Banks.
Black-winged stonefly, *Tæniopteryx nigripennis* Banks.
Salmon fly, *Tæniopteryx pacific* Banks.

[16] Banks named nearly all of the known California species in this order as well as in the Neuroptera and Trichoptera.

California thread-legged bug, *Ploiaria californiensis* Banks.
Emesa brevicoxa Banks.
Sacken's robber fly, *Dasyllis sackeni* Banks.
Pipunculus confraternus Banks.

Baron, O.T. Collected Coleoptera, Lepidoptera and other insects extensively in Mendocino and Fresno counties, California, and also in Arizona and northern Mexico. For him J. J. Rivers named the tiger beetle *Amblycheila baroni* Rivers, collected in Arizona. The Lepidoptera taken by him was described by W. H. Edwards, Henry Edwards, Charles Fish, and others. He returned to Germany in 1890.

FIG. 159.—Homer Franklin Bassett (1826–1902), the pioneer American student of the Cynipidæ, named many species from all over the country. (From Entom. News, 1902.)

Bassett, Homer Franklin[17] (Fig. 159). Born at Florida, Massachusetts, September 2, 1826; died at Waterbury, Connecticut, June 28, 1902. Pioneer American student of the Cynipidæ. His parents moved to Ohio while he was still a boy and he was educated at Berea (Ohio) University and Oberlin College. Afterwards he became a teacher and for many years spent the winters teaching in Ohio and Connecticut and the summers on his farm at Rockport, Ohio. A part of 1858 was spent in Kansas. In the spring of 1859 he opened a private school in Waterbury, Conn., which was closed in 1867 because of his ill health. He afterwards engaged in the insurance and real estate business and in 1872 became the librarian of the Bronson

[17] *Nat. Cyclop. Am. Biogr.*, vol. 6, p. 481, portrait (1896).
Entom. News, vol. 13, pp. 203–205, portrait (1902).
Entom. Mthly. Mag., vol. 38, p. 289 (1902).
Fowler, W. W., *Proc. Entom. Soc. London*, p. lix (1902).
Osten Sacken, C. R., *Record of my life work in entomology* (Cambridge, Mass., 1903), p. 40.
Wade, J. S., *Ann. Entom. Soc. Am.*, vol. 21, p. 493 (1928).
Horn, W., and Schenkling, S., *Index Litt. Entom.*, vol. 4, p. 1373 (1929).

Library in Waterbury, where he remained until March 1, 1901. He began publishing on the Cynipidæ as early as 1864 [18] and continued until 1900. He was a member of and closely affiliated with the Entomological Society of Philadelphia and the American Entomological Society and published chiefly in the proceedings and transactions of those organizations and also in the Canadian Entomologist. He described many important gallflies from this country. The articles of special interest are the following:

New Species of Cynipidæ, Can. Entom., vol. 13, pp. 51–57, 74–79, 92–113 (1881).

New Species of N. Am. Cynipidæ, Trans. Am. Entom. Soc., vol. 17, pp. 59–92 (1890); vol. 26, pp. 310–336 (1900).

His collection was presented to the American Entomological Society and is kept separate as the "Bassett Collection" in the Philadelphia Academy of Sciences.

Some of the important western species named by him are:

California gallfly, *Andricus californicus* (Bassett).
Live oak gallfly, *Andricus pomiformis* (Bassett).
Andricus agrifoliæ (Bassett).
parmula Bassett.
kingi Bassett.
Disholcaspis canescens (Bassett).
corallina (Bassett).
Diplolepis variabilis (Bassett).
Plagiotrochus suttoni (Bassett).
The species *Diplolepis bassetti* (Beutenmüller) bears his name.

Behr, Hans Herman [19] (Fig. 160). Born at Colthen, Duchy of Anhalt, Germany, August 18, 1818; died in San Francisco, California, March 6, 1904, at the age of eighty-five years and six months. Physician, scientist, author, poet, humorist, savant,

[18] *Desc. of several supposed new species of* Cynips, *with remarks on the formation of certain galls*, Proc. Entom. Soc., Phila., vol. 2, pp. 323–333 (1864).

[19] Eastwood, Alice, et al., *Rept. of the committee appointed to prepare and present an account of the life and services of Doctor Hans Herman Behr*, Calif. Acad. Sci. (San Francisco, 1905), 7 pp., portrait.

The excellent wit of Dr. Behr (*with short biography*), Argonaut, p. 182 (March 21, 1904).

Science, n. s., vol. 19, no. 485, p. 636 (April 15, 1904).

Entom. News, vol. 15, pp. 142–144 (1904) (from the *San Francisco Chronicle*).

Cottle, James E., *Pan-Pacific Entom.*, vol. 3, pp. 75–76 (1926).

Wade, J. S., *Ann. Entom. Soc. Am.*, vol. 21, p. 494 (1928).

A portrait of Dr. Behr, painted a few years before his death, hangs in the Bohemian Club, San Francisco, and is reproduced as a frontispiece in *The Hoot of the Owl*.—(San Francisco, A. M. Robertson, 1904.)

lepidopterist, are the words used to sum up the achievements of his long life. He was educated at the Universities of Halle, Wurzburg, and Berlin, taking his degree in medicine at the latter on March 23, 1843. "In 1898, on the occasion of his eightieth birthday, this degree was renewed by the University of Berlin upon the recommendation of Behr's lifelong friend, Rudolf Virchow. Such reward was an exceptional honor for a German-American physician." Among his scientific friends were Alexander von Humboldt, the great naturalist and traveler; Dietrich von Schlechtendahl, noted German entomologist; Rudolf Neumann, German entomologist; E. F. Germar, noted German entomologist; Ferdinand von Müller, great Australian botanist; William Hillebrand; Louis Agassiz, America's foremost zoölogist; F. Max Müller, German-English Sanscrit scholar; R. Virchow, the great German biologist and histologist, and many others. On the recommendations of Humboldt he went to Australia in 1844 to study the aborigines as well as to collect and investigate in botany and entomology. He extended his travels and studies to Java, Straits Settlements, East Indies, and South Africa and returned to Germany in 1848. As an ardent supporter of the socialistic movement of that time he found it advisable to leave his native country and late in 1848 he went to Brazil, visiting other South American countries and thence to the Philippine Islands, where he remained two years in Manila. Here he received a great amount of help from his associates of the Catholic Church. Behr came to California in 1851 and only left the state once, when in 1853 he went to Germany to bring his Polish bride, Miss Agnes Omylska, to his San Francisco home. His wife

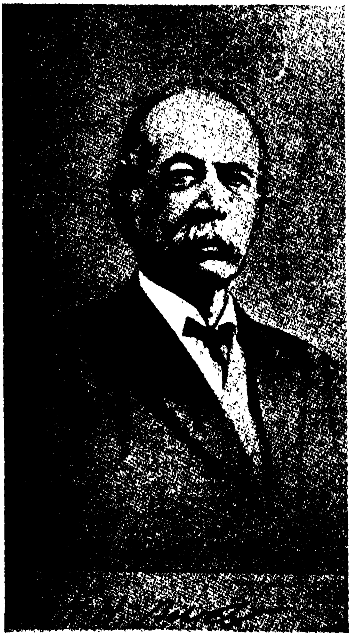

FIG. 160.—Hans Herman Behr (1818–1904) was an early leading scientist in the California Academy of Sciences. He was specially interested in botany and entomology. (After Alice Eastwood, et al., 1905.)

died after the birth of three children: two daughters, who returned in later years to Germany, and one son, Hans C., a civil engineer in South Africa at the time of his father's death. Behr's remaining years were devoted to the practice of medicine, to the study of plants and chiefly to butterflies, and to the activities of the Bohemian Club. As a physician he was "second to none in medical knowledge and kept well posted on the progress of medical science. It cannot be said that he loved his profession. Still less did he understand the art, so highly developed among modern physicians, of making it pay. On receiving the degree of medicine, in accordance with an old mediæval custom, he had to take a Latin oath to help the needy sick without regard to remuneration. This oath he kept conscientiously." He had some difficulties in his profession because of some unwarranted attacks from an unscientific German quack of the lower class, but he eventually overcame the difficulties by transferring his practice to a more intelligent class of patients.

His early scientific activities in California began when he became a member of the California Academy of Sciences, February 4, 1854, and were largely botanical in nature. For a number of years he was Professor of Botany at the California College of Pharmacy in San Francisco, during which time he wrote the Flora of San Francisco.[20] He was by far the best educated and most thoroughly trained scientist in the Academy and served as curator of Botany in 1855, vice-president from 1864 until his death, and during the last twelve years of his life as curator of Lepidoptera, for which he received a sufficient amount to provide for all his wants. On February 19, 1855, he presented a species of *Nepa*, which was the first insect ever presented at a meeting of the Academy. He had a most remarkable gift for learning languages and had a perfect mastery of Greek and Latin and could speak six or seven modern languages. "He was a purist in the formation of scientific terms, and such words as 'cotype' and a genitive like 'Salmonorum' aroused his contempt and wrath." He wrote a few German poems of a very high order, a story of life in the Philippines, published in the Atlantic Monthly, and a novel describing the life in California in a German periodical. As an after-dinner speaker he was a great success and his speeches before the Bohemian Club, which are both humorous and witty, contain a great deal of entomological information.[21]

[20] *San Francisco*, xiv + 364 pp. (1888).

[21] These speeches were collected and published by Behr in a small book entitled *The Hoot of the Owl* (San Francisco, A. M. Robertson, 1904), 227 pp.

His greatest love was the study of Lepidoptera, which he pursued vigorously to the end. He amassed a large collection which was presented to the California Academy of Sciences in about 1893. This valuable collection was destroyed in the San Francisco earthquake and fire of 1906. Some types and compared specimens, however, are to be found in the Herman Strecker Collection in the Field Museum of Natural History, Chicago.

He published sixteen entomological papers, chiefly on Lepidoptera. These articles were largely published in the Proceedings of the California Academy of Sciences, the first one on *Samia rubra;*[22] the second one on our California Argynnids.[23] He named a goodly number of species, a few of which are worthy of inclusion here:

FIG. 161.—James Behrens (1824–1898) collected insects in California for many prominent entomologists in Europe and America. (From a photograph loaned by Dr. F. E. Blaisdell. Also see Fig. 201.)

Coronis butterfly, *Argynnis coronis* Behr.
Argynnis leto Behr.
ruprestis Behr.
montivaga Behr.
adiaste Behr.
Gabb's butterfly, *Euphydryas gabbi* (Behr).
Cooper's butterfly, *Euphydryas cooperi* (Behr).
Hoffman's butterfly, *Euphydryas hoffmani* (Behr).
Terloot's pine butterfly, *Neophasia terlooti* Behr.
Ceanothus silk moth, *Samia rubra* Behr. This species is no longer accredited to Behr. (See silkworm, p. 234.)

Behrens, James[24] (Fig. 161). Born at Lübeck, Germany, June 30, 1824; died at San José, California, March 6, 1898, at the age of 74 years. One of the best pioneer collectors of California. He collected in all orders, but described few species himself. The

[22] Vol. 1, p. 47 (1855).
[23] Vol. 2, pp. 172–177 (1862).
[24] Ehrhorn, Edward M., *Entom. News*, vol. 9, p. 128 (1898).
Wade, J. S., *Ann. Entom. Soc. Am.*, vol. 21, p. 494 (1928).

Coleoptera was described by John L. LeConte, Geo. H. Horn, and E. Candèze; the Lepidoptera by G. D. Hulst, A. S. Packard, V. T. Chambers, A. R. Grote, R. H. Stretch, John B. Smith, and W. H. Edwards; the other orders by various systematists. He was elected resident member of the California Academy of Sciences on March 2, 1874.

His large personal collection was sent to the Museum of Lübeck, a few years before his death.

Among the interesting California and Western insects named for him are the following:

Aradus behrensi Bergroth	*Saprinus behrensi* Horn
Conozoa behrensi Saussure	*Chalcolepidius behrensi* Candèze (Mexico, Arizona)
Argynnis behrensi Edwards	*Elater behrensi* Horn
Hepialus behrensi Stretch	*Xestoleptura behrensi* (Leconte)
Pero behrensarius (Pack.)	*Leptinotarsa behrensi* Harold
Tinea behrensella Cham.	*Itoplectis behrensi* (Cresson)
Pleocoma behrensi Leconte	*Sirex behrensi* Cresson

Blaschke, Eduard L. Blaschke was employed as a Colonial doctor by the Russian American Company in Alaska and California and was particularly prominent in treating the natives both at Sitka and Unalaska during the smallpox epidemic in 1836–1837. In describing this epidemic among the Thlingit Indians at Sitka in 1836, Ivan Veniminov states, "Dr. Blaischke (Blaschke), who was then in the Colonies, at once began to vaccinate all who came to him. All those who were thus treated escaped the smallpox." (Report on the condition of the Orthodox Church in America, St. Petersburg, 1840. Translated and reviewed by Rev. A. P. Kashevaroff, Alaska Magazine, vol. 1, p. 148, 1927.)

He contributed a paper entitled Some Remarks on a Voyage in Baidarkas and on the Aleuts of the Fox Islands,[25] and also several medical treatises.[26]

[25] *Einige bemerkungen über das reisen in baidarken und über die Aleuten der Fuchsinseln*, Gesells. f. Erdk. zu Berlin Monats, u. die Verh. n. f., vol. 2, pp. 94–105 (1845).

Same paper in Russian, *Mosk. sbornik*, St. Petersburg, pp. 115–124, 260–265 (1848).

[26] *Topographia medica portus Novi Archangeliscensis sedio principalis rossicarum in septentrionali America* (St. Petersburg, Map. K. Weinhober & Son), 82 pp.

Also with title: *Dissertatio inauguralis sistens topographum medicano portus*, etc., St. Petersburg.

Blaschke came to California sometime prior to 1841 and was second only to Tschernikh as a collector of insects about Ross.

According to Kashevaroff, Blaschke left Alaska on the return of the twelfth voyage of the Russians around the world and arrived at Kronstadt on July 14, 1841.

His name is perpetuated in *Cibdelis blaschkei* Mann. Other interesting and important species collected by him in California are:

Buprestis fasciata Fabr. phase *langi* (Mann.). Taken at Sitka, but common along the Pacific Coast to California. The phase *langi* is the female of *B. fasciata*.

Cardiophorus californicus Mann. (Taken also by Tschernikh.)

Enoclerus eximius (Mann.).

White-marked spider beetle, *Ptinus fur* Linn. (About Sitka.)

Drug store beetle, *Sitodrepa panicea* (Linn.).

Dried fruit beetle, *Carpophilus hemipterus* Linn.

Hide and tallow dermestid, *Dermestes vulpinus* Fabr.

Common carrion dermestid, *Dermestes marmoratus* Say. (Also collected by Tschernikh.)

Saw-toothed grain beetle, *Oryzæphilus surinamensis* (Linn.) (Taken at Sitka.)

Rice weevil, *Sitophilus oryzæ* (Linn.). (Taken only at Sitka.)

Pterostichus vicinus Mann. (Also taken by Tschernikh.)

Celia californica (Dej.). (Also taken by Eschscholtz.)

Eleodes producta Mann.

Dentate eleodes, *Eleodes dentipes* Esch. (Also taken by Eschscholtz and Tschernikh.)

Blapstinus pulverulentus Mann.

Nautical borer, *Xylotrechus nauticus* (Mann.).

Sitona crinitus Gyll. (*Sitones seniculus* Mann.)

All of these species were determined and described by Mannerheim.[27]

Boheman, Carl Heinrich[28] (Fig. 162), was born at Jönköping, Sweden, July 10, 1796, and died at Stockholm, November 2, 1868. He was a great coleopterist and especially an authority on the Chrysomelidæ and Rhynchophora, having assisted C. J. Schœnherr in the great work on the Curculionidæ. He published forty-nine

[27] *Beitrag zur Käfer-Fauna der Aleutischen Insel, der Insel Sitka und Neu-Californiens*, Bul. Nat. Hist., Moscow, vol. 16, pp. 175–314 (1843).

[28] Hagen, H. A., *Bibliot. Entom.*, vol. 1, pp. 61–63 (1862).

Stål, C., *Ann. Soc. Entom. France* (4), vol. 9, pp. 105–106 (1869).

Dohrn, C. A., *Stett. Entom. Zeit.*, vol. 30, pp. 35–38 (1869); vol. 32, pp. 223–231 (1871).

Marseul, S. A. de, *L'Abeille*, vol. 22, pp. 141–144 (1884).

Wade, J. S., *Ann. Entom. Soc. Am.*, vol. 21, p. 494 (1928).

Horn, W., and Schenkling, S., *Index Litt. Entom.*, vol. 1, pp. 94–96 (1928).

important papers. Of our common species described by him, may be mentioned a number taken at San Francisco by the naturalists of the ship *Eugenie* under the command of C. A. Virgin on the voyage of 1851–1853. Most of these, however, were either synonyms or indeterminate species. The elater, *Elater ignobilis* Boh., the weevil, *Orchestes puberulus* Boh., and the apricot weevil, *Paraptochus sellatus* (Boh.), appear valid. Other species of importance described by him are the eggplant tortoise beetle, *Gratiana pallidula* (Boh.), the avocado seed weevil, **Heilipus lauri* Boheman, and the broad bean weevil, **Mylabris rufimanus* (Boh.).

Fig. 162.—Carl Heinrich Boheman (1796–1868). A Swedish coleopterist who described a number of important economic insects introduced into this country. (A photograph of a print furnished by C. F. Baker.)

Boheman also named a large number of curculionid weevils, including the cotton boll weevil, *Anthonomus grandis* Boh., *Cossonus subareatus* Boh., and very many species of North American Coleoptera.

His chief works relating to American entomology are: Monograph Cassididarum Holmiæ, Norstedt, I, 1850; II, 1854; III, 1855; IV, 1862. Kongliga Svenska Fregatten Eugenies Resa Omring Jorden, Entomologiska Bidrag. 217 pp., II Taf. (1858–1859). (Contains species taken in California.)

His collection is in the museum at Stockholm.

Boisduval, Jean Alphonse [29] (Fig. 163). Born at Ticheville in Normandy, France, June 17, 1799; died at the place of his birth,

* Introduced into California.

[29] Hagen, H. A., *Bibliot. Entom.*, vol. 1, pp. 64–66 (1862).
Capronnier, J. B., *Compt. Rend. Soc. Entom.*, Belg., p. xxxiii (1880).
Oberthur, Charles, *Ann. Soc. Entom. France* (5), vol. 10, pp. 129–138 (1880).
Entom. Nachr., vol. 6, p. 150 (1880).
Entom. Mthly. Mag., vol. 16, pp. 235–236 (1880).
Zoöl. Anz., vol. 3, p. 144 (1880).
Entomologist, vol. 13, p. 119 (1880).
Psyche, vol. 3, p. 71 (1880).

December 30, 1879. Boisduval was one of the most famous lepidopterists of France, one of the original members of the Entomological Society of France and an honorary member in 1866. Be-

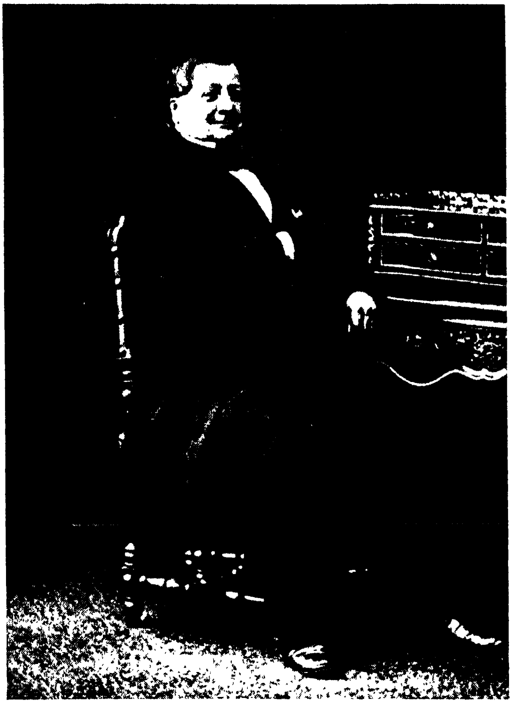

FIG. 163.—Jean Alphonse Boisduval (1799–1879) the great French entomologist who named so many of the common butterflies and moths of California which were collected by P. J. M. Lorquin during the gold rush days. (From a photograph taken at Paris in 1876, now in the G. Kraatz collection and loaned by Dr. Walther Horn, 1927.)

sides Lepidoptera he also described a few Homoptera and a great many Coleoptera. He was a careful worker and produced some fifty publications. He described the Lepidoptera collected during

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Girard, M., *Jour. Soc. Hort. France* (3), vol. 2, pp. 422–426 (1880).
Fauvel, A., *Ann. Entom.*, pp. 118–119 (1880).
Oberthur, Chas., *Etudes des Lépidoptèrologie Comparée*, fasc. 9 (Oct., 1913). Portrait.
Dow, P. R., *Bul. Brooklyn Entom. Soc.*, vol. 9, pp. 40–41 (1914).
Comstock, W. P., *Lycænidæ of California described by Boisduval*, Jour. N. Y. Entom. Soc., vol. 22, pp. 33–37 (1914).
Horn, W., and Schenkling, S., *Index Litt. Entom.*, vol. 1, pp. 98–100 (1928); vol. 4, p. 1378 (1929).

the voyages "de l'*Astrolabe*" [30] and "de la *Coquille*" [31] and also the species taken by P. J. M. Lorquin [32] in California, so that his name is familiar to all entomologists of this country and particularly to those of California, because his work is fundamental to our insect fauna.

He, therefore, described a number of important insects which are native of North America. Those collected in California by Lorquin are listed under Lorquin, pp. 694–697. In addition to these the following should also be listed:

* Latana aphis, *Cerataphis lataniæ* (Bdv.).
Sequoia sphinx, *Sphinx sequoiæ* Bdv.
* Soft bamboo scale, *Asterolecanium bambusæ* Bdv.
* Steel-blue ladybird beetle, *Orcus chalybeus* (Bdv.). This beetle, described as *Coccinella chalybea*, was taken from the collections of Dejean to whom the name was credited. It was originally collected in Australia (New Holland). He also named the bulb mite,* *Rhizoglyphus hyacinthi* Bdv.

His collection of Lepidoptera was sold to Charles Oberthur at Rennes, France. Some of the collection was purchased by William Barnes, Detroit, Michigan, and the Sphingidæ, purchased by B. Preston Clark, is on deposit in the Carnegie Museum at Pittsburg, Pennsylvania. Oberthur has redescribed and figured in color the California species in Etudes d'Entomologie, Descriptions d'insectes lépidoptères nouveaux ou peu connus, Rennes, I, 1876,—XX, 1896. The Elateridæ are now in the British Museum, and the types of the Curculionidæ, in the museum at Brussels.

His most important papers relating to North America are:

Histoire générale et iconographe des Lépidoptères et des Chenilles de l'Amérique septentrionale. (Paris, Roret, 1829–1842), livr. 1–26, 3 col. pls. (Assisted by John E. LeConte.)

Fauna Entomologique. Voyage L'Astrolabe, I, Lépidoptères, 267 pp. (1832); II, Coléoptères, 716 pp. (1835) (contains descriptions of *Orcus chalybeus* (Bdv.) which was from the Dejean collections, II, p. 595, 1835).

L'Entomologie du Voyage autour du Monde sur la Corvette la Coquille. (Paris, Arth. Bertrand, 1832–1835), 2 vols., 2 livr. col. pl.

Lépidoptères de la Californie. Ann. Soc. Entom. France (2), T. 10, pp. 275–

* Introduced into California.

[30] Boisduval, J. A., *Voyage de l'Astrolabe*, Part i, Lepidoptères, 267 pp. (1832); Part ii, Coléoptères, 716 pp. (1835).

[31] *L'Entomologie du Voyage autour du Monde sur la Corvette la Coquille* (Paris, Arth. Bertrand, 1832–1835), 2 vols., 2 liv. col. pls.

[32] See Lorquin, p. 697.

324 (1852); ser. 3, T. 3, Bul. pp. xxxi–xxxii (1855); *Ann. Entom. Soc. Belgique*, vol. 12, pp. 1–94 (1868–1869).

Note Nécrologique sur Lorquin. Ann. Soc. Entom. France (5), T. 3, pp. 5–10 (1873).

Burmeister, Hermann Carl Conrad [33] (Fig. 164). Born at Stralsund, Germany, January 15, 1807; died at Buenos Aires, Argentine Republic, May 2, 1892. One of the great general entomologists, zoölogists, and paleontologists. He was educated at the Universities of Greifwald and Halle and later became a professor at the Universities of Berlin and Halle. During his stay in Germany he published the Handbuch der Entomologie.[34] On November 1, 1861, he became director of the National Museum at Buenos Aires, which position he held until April 18, 1892. He was a voluminous writer and touched upon all branches of natural history. Entomology received the greatest share of his attention, he being particularly interested in anatomy and also in systematic work in the coleopterous family Scarabæidæ. In paleontology he was an authority on the trilobites. Seventy-five papers were written by him, chiefly on European and South American subjects, but he also described a number of North American species of insects which are of importance including:

FIG. 164.—Hermann Carl Conrad Burmeister (1807–1892), the great German entomologist, named many important native and introduced insects of this country. (After C. Berg, 1894.)

[33] Hagen, H. A., *Bibliot. Entom.*, vol. 1, pp. 106–108 (1862).
M'Lachlan, R., *Entom. Mthly. Mag.*, vol. 28, pp. 195, 221–222 (1892).
Entom. News, vol. 3, pp. 191–192 (1892).
Psyche, vol. 6, p. 300 (1892).
Ann. Soc. Argentina, vol. 33, pp. 145–150 (1892).
Entom. Nachr., vol. 18, pp. 220–222 (1892).
Godman, F. D., *Proc. Entom. Soc. London*, pp. xlvi–xlvii (1892).
Berg, Carlos, *Ann. Soc. Entom. France*, vol. 63, pp. 705–712, portrait (1894); *Ann. Mus. Buenos Aires*, vol. 4, pp. 315–357 (1895).
Wade, J. S., *Ann. Entom. Soc. Am.*, vol. 21, p. 495 (1928).
Horn, W., and Schenkling, S., *Index Litt. Entom.*, vol. 1, pp. 157–160 (1928); vol. 4, p. 1383 (1929).

[34] Vol. I (1832); II (1835–1838); III (1842); IV, pt. 1 (1844), pt. 2 (1845); V (1847).

Black and orange desert grasshopper, *Tæniopoda eques* (Burmeister).
Dark-striped locust, *Melanoplus femoratus* (Burmeister).
Dark-lipped lacewing, *Chrysopa rufilabris* Burmeister.
Chlorophane lacewing, *Chrysopa chlorophana* Burmeister.
Amphiagrion saucium Burmeister.
Ischnura denticollis (Burmeister).
Libellula luctuosa Burmeister.
Pachydiplax longipennis Burmeister.
Cactus joint bug, *Chelinidea tabulata* (Burmeister).
Field mouse louse, *Hoplopleura acanthopus* (Burmeister).
* Buffalo louse, *Hæmatopinus tuberculatus* (Burmeister).
* Sucking goat louse, *Linognathus stenopsis* (Burmeister).
* Spined rat louse, *Polyplax spinulosa* (Burmeister).
Desert June beetle, *Ochrosidia villosa* (Burmeister).

His first private collection is in the Museum of the University of Halle, Germany, while his later material is in the National Museum at Buenos Aires.

Candèze, Ernst Charles Auguste [35] (Fig. 165). Born at Liége, Belgium, February 27, 1827; died at his residence at Glain, near Liége, June 30, 1898. He was a pupil of the great coleopterist, Jean Theodore Lacordaire, at Liége. He studied medicine in his native city and in Paris and became a physician and director in a noted hospital for the insane. He studied Coleoptera so effectively during his spare time that he became the greatest world authority of the Elateridæ.

His greatest work was a monograph on the subject of this family which appeared in four volumes in 1857–1860.[36] These were supplemented by articles in the Annals of the Belgian Entomological Society, of which he was one of the founders. During his life he was intimately associated first with Lacordaire and later with M. F. Chap-

* Introduced into California.

[35] Hagen, H. A., *Bibliot. Entom.*, vol. 1, pp. 112–113 (1862).
Lameere, Aug., *Biography, bibliography and portrait*, Ann. Soc. Entom. Belgique, vol. 42, pp. 504–519 (1898).
Trimen, R., *Proc. Entom. Soc. London*, p. liii (1898).
M'Lachlan, R., *Entom. Mthly. Mag.*, vol. 34, pp. 215–216 (1898).
Entom. News, vol. 9, p. 208 (1898).
Selys de Longchamps, Baron E., *Annuaire de l'Acad. Royale des Belgique*, vol. 66, pp. 421–436, portrait (1900).
Mém. Soc. Sci. Liége (3), vol. 1, pp. 2–18, portrait (1900).
Wade, J. S., *Ann. Entom. Soc. Am.*, vol. 21, p. 495 (1928).
Horn, W., and Schenkling, S., *Index Litt. Entom.*, vol. 1, p. 167 (1928).

[36] *Mem. Soc. Sci. Liége*, 1, xii, 400 pp. (1857); 2, xiv, 543 pp. (1859); 3, xv, 512 pp. (1860); 4, xvii, 534 pp. (1863).

uis, Selys de Longchamps, and Robert M'Lachlan of England. In addition to his systematic work he was the author of several entomological romances, of which one was "The Adventures of a Cricket" and another "The Doryphora in Belgium," the latter referring to the Colorado potato beetle scare in 1877. He was also much interested in horticulture, photography and music. Candèze was an Officer of the Order of Leopold, a Member of the Belgian Academy and of the Academy of Sciences of Liége, one of the five Commissioners of the Natural History Museum at Brussels. He was also a member of many foreign entomological societies, including that of London from 1860, and of France from 1856 to 1882, and was subsequently on the honor list.

Fig. 165.—Ernst Charles Auguste Candèze (1827–1898). He was a great Belgian physician and entomologist, who, in his time, became the world authority of the coleopterous family Elateridæ. (From a photograph loaned by Dr. F. Blaisdell, 1927.)

He made several collections of Elateridæ, the first of which passed into the possession of E. W. Janson and, through F. D. Godman and O. Salvin, to the British Museum. Another collection of Elateridæ, Lamellicornia, Lucanidæ, Longicornia and a large collection of Diptera, also made by him, are in the Museum at Brussels, Belgium.

Some species of Elateridæ named by him are:

Adelocera sparsa Cand.	*Agriotes inversus* Cand.
Limonius fulvipilis Cand.	*Drasterius præses* Cand.
Pheletes pilosulus Cand.	*Elater horni* Cand.
Ludius lecontei (Cand.)	*Ectamenogonus partitus* (Cand.)
Hemicrepidius hirtus Cand.	*Cardiophorus stigmaticus* Cand.
H. lecontei Cand.	*C. luridipes* Cand.

Casey, Thomas Lincoln [37] (Fig. 166). Born at West Point, N. Y., February 19, 1857; died in Washington, D. C., February 3, 1925, at the age of 67 years. He was born of two generations of army officers and was himself predestined to military life, although this was by no means a burden to him—rather it afforded him the necessary time to accomplish on the side what few men are able to do in a normal lifetime. He graduated from West Point in 1879 and began to climb the ladder of rank as an army engineer, which gave him a most unusual opportunity for travel and for collecting Coleoptera throughout the country. He began by accompanying the Transit of Venus Expedition to the Cape of Good Hope in 1882–1883. He was in California from 1885–1886; Texas in 1886; Newport, R. I., in 1888; New York in 1888–1893; Virginia in 1895–1899; Mississippi in 1901; St. Louis, Mo., in 1902–1906; Washington, D. C., in 1907–1925. He became Lieutenant-Colonel in 1906; member and engineering secretary of the Light House Board in 1906–1910; Colonel in 1909; and was retired March 1, 1912. He amassed a very large collection of Coleoptera, chiefly by purchase, and collected extensively himself. In checking over the Leng Catalogue

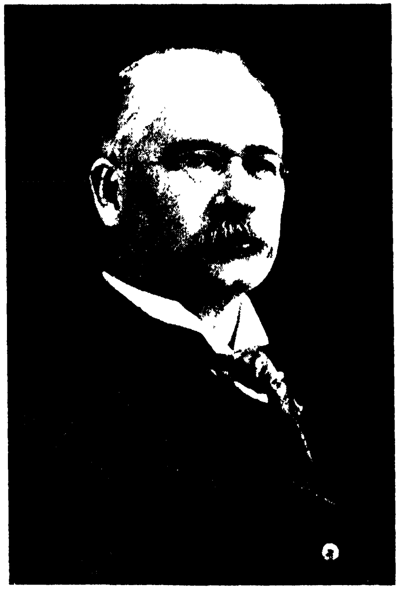

FIG. 166.—Thomas Lincoln Casey (1857–1925), one of America's greatest coleopterists, collected and described more North American beetles than any other man. (This photograph, taken about 1913, was furnished by Dr. L. O. Howard. Also see Fig. 258.)

[37] Grinnell, Fordyce, Jr., *Bul. Brooklyn Entom. Soc.*, vol. 9, p. 72 (1914).
Schwarz, E. A., and Mann, W. M., *Colonel Thomas Lincoln Casey*, Proc. Entom. Soc. Wash., vol. 27, pp. 41–43, portrait (1925).
Leng, C. W., *Thomas Lincoln Casey*, Entom. News, vol. 36, pp. 97–100 (1925); Nat. Hist., vol. 25, pp. 206–207 (1925).
Blaisdell, F. E., *Pan-Pacific Entom.*, vol. 2, pp. 90–91 (1925).
Hatch, Melville H., *Thomas Lincoln Casey as a coleopterist*, Entom. News, vol. 37, pp. 175–179, 198–202, portrait (1926).
Wade, J. S., *Ann. Entom. Soc. Am.*, vol. 21, pp. 495–496 (1928).

of Coleoptera (1920), one is impressed with the fact that the name Casey follows more species than that of any other, which is an indication of the great amount of work done by him. "To many Coleopterists it must seem incredible that after the exhaustive work of LeConte, Crotch, and others, almost half our species waited for Casey's discovery and description." (C. W. Leng.) Some of the high lights of his interesting personality and career may be gained from his biography by Hatch:

> Casey took up the study of Coleoptera as a hobby. He inherited sufficient means, not only to render him financially independent, but to purchase specimens and literature in large quantities and to publish the results of his investigations privately, when such appeared desirable. . . .
>
> The basis of Casey's specific discrimination was an increased attention to details of habitus and sculpture. . . .
>
> One of Casey's leading characteristics was that he did not regret . . .
>
> . . . Analysis, rather than synthesis, was always his dominant interest His tables are usually to species, less frequently to genera and tribes, only very rarely to the primary family divisions and never to groups above the family. . . .
>
> Among the American collectors from whom he obtained specimens by purchase or otherwise, may be mentioned Wickham, Fall, Manee, Knaus, Blatchley, and Frost. . . .
>
> He came to play a lone hand. He never consulted the other American collections. . . .
>
> Furthermore, Casey had little regard or interest for the bibliographical aspect of his subject. . . .
>
> Casey must be regarded as a prophet of the infinite complexity of taxonomic coleopterology.
>
> With the utmost concern for posterity, his collection and library were left to the National Museum in Washington. There a special room was provided for their reception, which Mrs. Casey, who survived her husband, generously equipped with two binocular microscopes and adorned with a portrait in oil of the famous coleopterist. There future students may continue the study of the problems in which Casey was so deeply interested.

He was a charter member of the Entomological Society of Washington.

Casey published, in all, seventy-six papers in various periodicals. His more important later papers appeared in his privately issued Memoirs on the Coleoptera.[38]

While in California, Casey collected from San Diego to Eureka and secured a wealth of new material but, as he worked largely on the Pselaphidæ, Scydmænidæ, Staphylinidæ and other obscure

[38] Lancaster, Pa., vol. 1 (1910) to vol. 11 (1924).

families, the vast majority of his species are not familiar to most entomologists. Among the western species, there are some which are worthy of note.

Red spider destroyer, *Somatium oviformis* (Casey).
Fruit notoxus, *Notoxus constrictus* Casey.
Red spider eater, *Sethorus picipes* Casey.
Interrupted ladybird beetle, *Neomysia interrupta* Casey.
Diplotaxis popino Casey.
Green fruit beetle, *Cotinis texana* Casey.
Huisache girdler, *Oncideres trinodatus* Casey.
The adaleres, *Adaleres ovipennis* Casey.

Chapin, S. F. [39] Born in Michigan, March 12, 1839; died near Auburn, California, March 14, 1889, aged 50 years, 2 days. When he was only six years old his father died and his family returned to Massachusetts, where he received his early education. In 1863 he graduated from the College of Physicians and Surgeons, New York City, and was for a time Assistant Surgeon under General Sheridan in the Civil War. Because of failing health he came to Auburn, California, on March 12, 1866, in which year also he married Maria Endicott in San Francisco. In 1878 he moved to San José where he lived until 1885. Here he not only practiced the professions of medicine and surgery, but became very much interested in horticulture and particularly in the control of insect pests on fruit trees. He was one of the first to note the presence of coccids or scale insects and early called attention to the ravages of the San José scale before it became known to the scientific world in 1880.

Recognizing his ability along horticultural lines he was appointed a member of the California Board of State Horticultural Commissioners as commissioner from the San Francisco District, April 5, 1881. On June 29, 1882, he was appointed a member of a special committee of the Board, with Matthew Cooke and Ellwood Cooper, to consider means for the destruction and prevention of the spread of the cottony cushion scale in California. He was a most active and useful member of the board and was elected vice-president September 28, 1882. On April 26, 1883, he succeeded Wm. M. Boggs, as Inspector of Fruit Pests, and continued to serve as the Commissioner from the San Francisco District. As inspector of

[39] *Placer Herald*, Auburn (March 16, 1889).
Pacific Rural Press, vol. 37, p. 273 (March 23, 1889).

fruits he was most active in promoting ways and means of controlling insect pests and conducted many experiments with the known insecticides of that time as is shown by his published reports. He continued in this position until November 21, 1885.

In 1887 he returned to his family home in Auburn where he remained with the exception of the year 1888 spent in Los Angeles, following the profession of physician and surgeon. On the afternoon of March 14, 1889, while returning from a professional call, he was drowned while fording the Auburn Ravine, between Ophir and Auburn. No one was witness to the accident, but the horse and upturned buggy bore testimony of the tragedy; his body was not recovered from the water until some three hours later. Like his associates Matthew Cooke and Ellwood Cooper he was a self-made horticulturist. Each of these men performed a real and lasting service to horticulture in California when it was needed most.

Some of his important published articles are:

Report of the Commissioner for the San Francisco District, Calif. Bd. State Hort. Com., First Rept., pp. 65–88, 6 figs. (1882).

The progress of the orchards of California during 1883, ibid., Rept. 1883, pp. 12–27 (1883).

Insect pests, ibid., Rept., 1884, Bul. 1, pp. 18–22; *Bul. 2,* pp. 22–23 (1884).

Report of the inspector of fruits, ibid., pp. 24–49 (1884).

Clarke, Warren Thompson [40] (Fig. 167). Born in San Francisco, California, March 15, 1863; died at his home, 2317 LeConte Avenue, Berkeley, California, April 18, 1929. He graduated from the Agricultural College of the University of California in 1903. During his student days he became assistant to C. W. Woodworth and was field assistant in Entomology, 1902–1906. During this period, prior to graduation, he worked on the life history and control of the grape leafhopper,[41] potato tuber moth,[42] and peach twig borer,[43] and did some important work on the Aphididæ.[44]

[40] *Pacific Rural Press,* vol. 117, p. 544 (April 27, 1929).

Essig, E. O., *Jour. Econ. Entom.,* vol. 22, pp. 608–609, pl. 18, portrait (1929).

[41] *California vine-hopper,* Calif. Agr. Expt. Sta., Rept. for 1897–1898, pp. 179–181 (1900).

[42] *The potato-worm in California,* Calif. Agr. Expt. Sta., Bul. 135, 30 pp., 10 figs. (1901).

[43] *The peach-worm, ibid.,* Bul. 144, 44 pp., 19 figs. (1902).

[44] *Conditions favoring wing development in* Nectarophora rosæ (Linn.), Calif. Jour. Technology, vol. 1, pp. 96–99 (1903).

The hop aphis, Calif. Agr. Expt. Sta., Bul. 160, 13 pp., 7 figs. (1904).

He also acted as field agent in Entomology from 1902–1905. Upon graduation he became Assistant Entomologist and Field Agent in the Division of Entomology which position he held until 1906. During this period he published two technical papers; the first on California Aphididæ [45] and the second on a new sawfly.[46] A bulletin was also published on the hop aphis.[47]

Fig. 167.—Warren Thompson Clarke (1863–1929). A California entomologist who is particularly noted for his early work on the control of the peach twig borer and other injurious insects. (Photograph taken in 1919.)

In 1906 he occupied a temporary position in the Alabama Polytechnic Institute, but returned to California in 1907 to become Assistant Professor of Horticulture and Superintendent of Farmers' Institutes in the University of California and devoted himself to general agricultural extension work thereafter. In 1911 he became Associate Professor of Horticulture and in 1913, Professor of Agricultural Extension, from which position he retired as Emeritus, March 16, 1928. During the period since 1907 he published a great many articles in the agricultural press of California and a number of station bulletins. His last entomological contribution was an article on ant control on shipboard, published in 1922.[48]

Clarke's greatest contribution to entomology was the perfection of the lime-sulfur spray for the control of the peach twig-borer which soon became generally accepted throughout the entire country. His whole work in economic entomology was of an excellent type. The paper on Aphididæ was the first to appear on this important family in California.

California insects named and described by him are:

[45] *A List of California Aphididæ*, Can. Entom., vol. 35, pp. 247–254 (1903).
[46] *Description of a new species of sawfly*, *ibid.*, vol. 38, pp. 351–352 (1906).
[47] Calif. Agr. Exp. Sta., *Bul. 160*, 13 pp., 7 figs. (1904).
[48] *Jour. Econ. Entom.*, vol. 15, pp. 329–333 (1922).

Bamboo aphis, *Myzocallis arundicolens* (Clarke).
Ceanothus aphis, *Aphis ceanothi* Clarke.
California willow aphis, *Macrosiphum californicum* (Clarke).
Tomato aphis, *Myzus lycopersici* (Clarke).
Aphis alamedensis Clarke, *A. mori* Clarke, *Macrosiphum jasmini* (Clarke), (*Nectarophora*), *M. valerianiæ* (Clarke), *M. baccharidis* (Clarke) have never been satisfactorily placed because all of his original types were lost.
Cherry fruit sawfly, *Hoplocampa cookei* (Clarke) (*Dolerus*). The type of this species has also disappeared.

Cockerell, Theodore Dru Alison (Fig. 168). Born in Norwood, England, August 22, 1866; at present professor of zoölogy, University of Colorado, Boulder, Colorado. One of the greatest biologists in America today and one of the few who have done vasts amounts of systematic work in many orders of animals and also on plants and fossils. He is an authority in the insect family Coccidæ and the order Hymenoptera; geographical distribution of life; variation of animals and plants; mullusca; natural history of the Rocky Mountains; botany, especially the genus *Helianthus;* evolution; fossil insects and plants; and scales of fishes. He was educated in private schools in England and in Middlesex Hospital School (did not take a degree) and received the degree of Sc. D. from Colorado College in 1913. He was curator of the Public Museum, Kingston, Jamaica, 1891–1893; New Mexico Agricultural Experiment Station, 1893–1901; professor of entomology and zoölogy, New Mexico Agricultural College, 1893–1896, 1898–1900; teacher of biology New Mexico Normal University, 1900–1903;

FIG. 168.—Theodore Dru Alison Cockerell (1866–   ), is one of the greatest and most versatile entomologists in the entire country. He has described many insects, especially coccids and bees, and is now the leading insect paleontologist in America. (From a photograph taken in 1926.)

consulting entomologist, Arizona Agricultural Experiment Station, 1901–1909; curator Colorado College Museum, 1903–1904; lecturer in entomology, University of Colorado, 1904–1906, professor of systematic zoölogy, 1906–1912; professor of zoölogy, 1912 to present. He has traveled a great deal, having made three trips to Europe, one to South America, one to Japan and Eastern Siberia, one around the world through India, Siam, and New Zealand.

As previously stated he has worked in many groups of animals and has described a great many new species and published over three thousand papers in practically all of the journals dealing with systematic entomology and in many of the other biological periodicals. Aside from entomology he has contributed important papers on the Mollusca and other invertebrates of Colorado and has done considerable work on the scales of fishes. In addition to his biological writings he is the author of a great many poems, reviews, notices, and comments of sociological importance.

Some of his most important works in entomology are:

General Entomology:

Some Mexican and Japanese injurious insects liable to be introduced into the United States, U. S. Dept. Agr., Div. Entom., Tech. Ser., no. 4, 56 pp., illus. (1896).

The bees of the genus Colletes *found in New Mexico*, Ann. Mag. Nat. Hist., vol. 19, pp. 39–52 (1897).

Directions for collecting and preserving scale insects, U. S. Nat. Mus., Bul. 39, 9 pp. (1897).

The food plants of scale insects (Coccidæ), *ibid.*, Proc., vol. 19, pp. 725–785 (1897).

The San José scale and its nearest allies, U. S. Dept. Agr., Div. Entom., Tech. ser., no. 6, 31 pp., illus. (1897).

A check list of the Coccidæ, Ill. State Lab. Nat. Hist., Bul., vol. 4, art. 11, pp. 318–339 (1896); suppl., vol. 5, art. 7, pp. 389–398 (1899).

Insecta, Rhynchota, Hemiptera—Homoptera in Biologia Centrali-Americana, vol. 2, pt. 2, 33 pp., 13 figs. (1899).

Genus Megachile *in New Mexico*, Ann. Mag. Nat. Hist., vol. 6, pp. 7–19 (1900).

Tables for the identification of Rocky Mountain Coccidæ (scale insects and mealybugs), Univ. Colo. Studies, vol. 2, no. 3, pp. 189–203 (1905).

The care of entomological types, U. S. Dept. Agr., Bur. Entom., Bul. 60, pp. 51–52 (1906).

North American bees of the family Anthophoridæ, Trans. Am. Entom. Soc., vol. 32, pp. 63–116 (1906).

The scale insects of the date palm, Ariz. Agr. Exp. Sta., Bul. 56, pp. 185–192, 5 pls. (1907).

Rocky Mountain bees (with Robbins, W. W.), Univ. Colo. Studies, **vol. 7,** pp. 179–195 (1910).

New Osmia *from California*, Can. Entom., vol. 21, pp. 120–122 (1910).

The North American bees of the genus Nomia, U. S. Nat. Mus., Proc., vol. 38, pp. 289–298 (1911).

Names applied to bees of the genus Nomada, *found in North America, ibid.*, Proc., vol. 41, pp. 225–243 (1912).

Names applied to bees of the genus Osmia, *found in North America, ibid.*, vol. 42, pp. 215–225 (1912).

Names applied to the cucerine bees of North America, ibid., Proc., vol. 43, pp. 261–273 (1913).

New parasitic Hymenoptera of the genus Eiphosoma, *ibid.*, vol. 46, pp. 61–64 (1914).

Names applied to the North American bees of the genera Lithurgus, Anthidium, *and allies, ibid.*, vol. 47, pp. 87–94 (1915).

New North American bees of the genus Andrena (with Viereck, H. L.), *ibid.*, vol. 48, pp. 1–58 (1915).

Some Diptera (Microdon) *from nests of ants* (with Andrews, Hazel), *ibid.*, vol. 51, pp. 53–56, illus. (1917).

Parasitic bees (Epeolinæ and Melectinæ) in the collection of the California Academy of Sciences (with Sandhouse, Grace), Calif. Acad. Sci. (4), vol. 13, no. 19, pp. 305–324 (1924).

Anthidiine bees in the collection of the California Academy of Sciences, ibid. (4), vol. 14, no. 11, pp. 185–215; no. 15, pp. 345–367 (1925).

Some bees in the collection of the California Academy of Sciences, Pan-Pacific Entom., vol. 3, pp. 80–90 (1926).

Fossil Insects:

Miocene fossil insects, Acad. Nat. Sci., Phila., Proc., vol. 66, pp. 634–648 (1914).

New Tertiary insects, U. S. Nat. Mus., Proc., vol. 52, pp. 373–385, pl. 81 (1917).

Some fossil insects from Florissant, Colorado, ibid., vol. 44, pp. 341–346, pl. 56 (1913); vol. 53, pp. 389–392 (1917).

Some American fossil insects, ibid., vol. 51, pp. 89–106, pl. 2 (1917).

New species of North American fossil beetles, cockroaches, and tsetse flies, ibid., vol. 54, pp. 301–311, pls. 54–55 (1919).

Eocene insects from the Rocky Mountains, ibid., vol. 57, pp. 233-260, pls. 32–36 (1921).

Some Eocene insects from Colorado and Wyoming, ibid., vol. 59, pp. 29–39, pl. 8 (1922).

Some Eocene insects of the family Fulgoridæ (with Sandhouse, Grace), *ibid.*, vol. 59, pp. 455–457 (1922).

Fossil insects in the U. S. National Museum, ibid., vol. 64, art. 13, 15 pp., 2 pls. (1925).

Books:

Zoölogy: a textbook for colleges and universities (Yonkers-on-Hudson, N. Y., World Book Co., 1920), xi+558 pp., 211 figs.

Zoölogy of Colorado (Univ. of Colo., Boulder, Colo., 1927), pp. vii + 262, illusts., pls.

A few of the very many Western insects named by Cockerell are:

Manzanita leaf-gall aphis, *Tamalia coweni* (Ckll.).
Strawberry aphis, *Myzus fragæfolii* Ckll.
Chenopodium orthezia, *Orthezia annæ* Ckll.
Cottony cochineal scale, *Dactylopius confusus* (Ckll.).
Cottony cactus scale, *Eriococcus coccineus* Ckll.
Red date scale, *Phœnicococcus marlatti* Ckll.
Saltmarsh grass mealybug, *Pseudococcus salinus* (Ckll.).
Artemisia scale, *Amonostherium lichtensioides* (Ckll.).
Cottony bamboo scale, *Antonina crawi* Ckll.
Horned lac scale, *Tachardiella cornuta* (Ckll.).
Fruit tree pulvinaria, *Pulvinaria amygdali* Ckll.
Irregular wax scale, *Ceroplastes irregularis* Ckll.
Brown elm scale, *Lecanium canadense* (Ckll.).
Calico scale, *Lecanium cerasorum* Ckll.
Ehrhorn's oak scale, *Mycetococcus ehrhorni* (Ckll.).
Chamise scale, *Lecaniodiaspis rufescens* (Ckll.).
Howard's scale, *Aspidiotus howardi* Ckll.
Gelatinous white fly, *Aleuroplatus gelatinosus* (Ckll.).
Barberry white fly, *Bemisia berbericola* (Ckll.).
Columbine white fly, *Aleyrodes aureocincta* Ckll.
Bigelovia gall fly, *Eurosta bigeloviæ* Ckll.
Prospaltella peltatus (Ckll.).
Aphycus howardi Ckll. (New Mexico).

Halictidæ (Cockerell has described many of the bees in this family).
Anthophoridæ (Cockerell is an authority on this family).
Colletidæ (Cockerell worked up many of the bees of this family).
Megachilidæ (Cockerell is one of the foremost authorities on this family).
Megachile lippiæ (Ckll.).
calogaster Ckll.
perihirta Ckll.

Some of the common important insects named for Cockerell are:

Chrysopa cockerelli Banks.
Kermes cockerelli Ehrh.
Pseudococcus cockerelli (King and Tinsley).
Pulvinaria cockerelli King.
Lecanium cockerelli Hunter.
Phenacaspis cockerelli (Cooley).
Thamnotettix cockerelli Ball.
Paratrioza cockerelli (Sulc).
Xestoleplura cockerelli (Fall).
Aristotelia cockerella Busck.
Gelechia cockerelli Busck.
Tortrix cockerellana Kearfott.
Abebæa cockerella Busck.
Acrolophus cockerelli Dyar.
Incurvaria cockerelli Busck.
Aphycus cockerelli Howard.

Compere, George[49] (Figs. 118, 174). Born at Davenport, Iowa, September 8, 1858; died in San Francisco, May 17, 1928, and was interred in the Mount Olivet Cemetery of that city.

When the cottony cushion scale was first noted in Los Angeles County in 1877 he had charge of an orange orchard located on Washington Street and endeavored to control the pests by various kinds of sprays. In 1884, finding sprays of no avail, he covered a twelve-year-old seedling orange tree with a tent and fumigated it with burning sulfur for about four hours. The scale was reported alive when the tent was removed, but in less than an hour not a leaf was left on the tree. This was one of the first experimental fumigations of orange trees.[50]

In 1898 he was employed by the California State Board of Horticulture as a foreign collector of beneficial insects to be introduced into the state to combat the many injurious insects which were doing much damage to the many horticultural crops. Thus he entered into a type of work which was to take him over much of the world and in which he spent twelve years of arduous labor. He set sail from San Francisco in November, 1898, for Australia, stopping at Honolulu on the way. A more or less complete itinerary of his field work is given under the title "foreign collectors," pp. 366–380, and is therefore omitted in this sketch. Suffice it to say that he collected parasites and predators chiefly in southern Asia and that he visited many parts of Australia, Fiji, Ceylon, Java, Singapore, Saigon, Hongkong, Canton, Amoy, Manila, Japan, Egypt, Palestine, Asiatic Turkey, Italy, Spain, India (Bombay, Poona, Nagpur, Calcutta), Brazil, and perhaps other places.

In 1901 he resigned from the employ of the California State Board of Horticulture to enter the services of the State of Western Australia where he reported for duty in September. On his trip to California in February, 1904, he entered the joint service of California and Western Australia until November 5, 1910, when he resigned from the latter and returned to California. The California Horticultural Commissioner had replaced the old State Board of Horticulture and he became affiliated with the administration of

[49] Howard, L. O., and Fiske, W. F., U. S. Dept. Agr., Bur. Entom., *Bul. 91*, pp. 38–39 (1911).
Maskew, Frederick (A poem), Calif. State Hort. Com., *Mthly. Bul.*, vol. 5, p. 66 (1916).

[50] Compere, Geo., *Origin of fumigation with hydrocyanic-acid gas in California*, Calif. State Dept. Agr., Mthly. Bul., vol. 11, p. 438 (1922).

J. W. Jeffrey and was associated with E. K. Carnes, in charge of the state insectary work at Sacramento.

When the Mediterranean fruit fly was discovered at Honolulu in October, 1910, Compere realized the danger of its being introduced into California and at once endeavored to secure the necessary legal action to prevent its entrance. The quarantine and regulations finally adopted were due to his persistent demands and after they were provided he was placed in the quarantine service in San Francisco, where the last part of his life was devoted to excluding fruit flies and other insect pests from this state. With his wide knowledge and experience of these destructive flies, he was able to perform a priceless service to the state in this connection.

During January and February, 1919, he was appointed by the Federal Horticultural Board to inspect the conditions in New Orleans to determine the needs for quarantine at that port.[51]

Concerning him Howard and Fiske[52] make this statement which fully characterizes the man:

> Mr. Compere has collected many beneficial species attacking many different injurious insects. He is an indefatigable worker, and his untiring qualities and his refusal to accept failure are well shown in his search for the natural enemies of the fruit fly of Western Australia, *Ceratitis capitata* Wied.

In my opinion his greatest service was rendered to California in his absolute interest and loyalty in connection with the exclusion of fruit flies and other injurious pests from this state!

In his honor Howard named for him the genus *Comperiella*, a primary parasite of the red scale, and Ashmead named *Aphiobetoideus comperei* and the elasmid parasite, *Myiocnema comperei*. The last two have been reared from black scale, but their exact status as parasites is yet in doubt.

Comstock, John Henry (Fig. 169). Born at Janesville, Wisconsin, February 24, 1849; at present emeritus professor of entomology, Cornell University, Ithaca, N. Y. He founded the department of entomology at Cornell University, the first department of this science to be established anywhere. During the forty years of his active professorship, he was one of the leading teachers of

[51] *Jour. Econ. Entom.*, vol. 12, p. 131 (1918).
[52] Howard, L. O., and Fiske, W. F., *op. cit.*, Bul. 91, p. 39 (1911).

entomology in the world and trained so many men in this profession that he has had a very great influence upon the development of entomology throughout the entire country and in many parts of the world. He graduated at Cornell University with the degree of B. S. in 1874 and for forty years thereafter he led to pronounced success the department of entomology of his Alma Mater and made it one of the most celebrated of its kind in America.

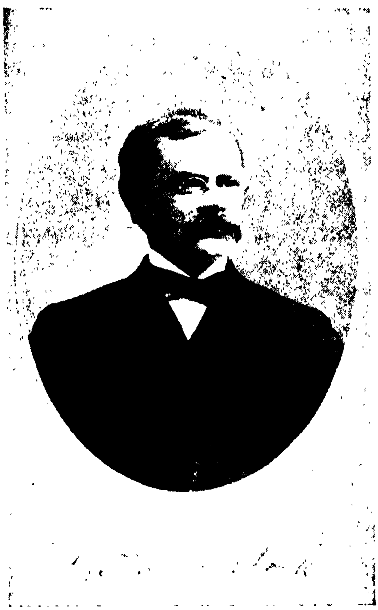

FIG. 169.—John Henry Comstock (1849–), is one of America's greatest entomological teachers and writers. His wholesome influence has been felt in every part of the country. He described the San José scale and a number of other important coccids. (From a photograph loaned by Dr. E. P. Felt.)

From 1879–1881 he was entomologist of the U. S. Department of Agriculture and it was during this term of office that he visited California in July and September, 1880, to study the scale insects on orange trees. On July 24, 1880, he gave a lecture before the California State Horticultural Society at San Francisco on Scale Insects Injurious to Fruit and Other Trees.[53] During this year also he prepared his valuable report on Scale Insects [54] in which he described a large number of new species including the San José scale, walnut scale, grape scale, and many other important species. (See list on p. 578.)

He was later non-resident entomologist at Stanford University until the appointment of V. L. Kellogg in 1893. During his stay there he gave a special course of instruction by means of lectures and laboratory work in the study of insects. This course started January 4, 1892, and continued for three months. In January and

[53] *Pacific Rural Press*, vol. 20, pp. 210–211 (Oct. 20, 1880). At this time he stated that the black scale was the most common coccid in the state. The red scale was important, but the specific name unknown, although described by Maskell in 1878.

[54] U. S. Commissioner of Agriculture, *Rept. 1880*, pp. 276–373, pls. iii–xvii (1881).

February of the same year he gave lectures on entomology at the State Normal School at San José.[55]

He is a member of all the important American entomological and related societies and associations and an honorary fellow of entomological societies of Belgium, London, and France.

As a writer Comstock is known to all students of entomology. In addition to the works on scale insects he is a prominent authority on classification, anatomy, biology, and the wings of insects and the classification and biology of spiders and other arachnids. Besides the report on Scale Insects, already referred to, he contributed the following important papers, reports, and books:

FIG. 170.—Anna Botsford Comstock (1854–1930), wife of Prof. J. H. Comstock, ably assisted him in his entomological work and also made a national reputation in entomological illustration and engraving and in nature study. (From a photograph loaned by Dr. E. P. Felt.)

Report upon cotton insects, U. S. Dept. Agr., 511 pp., 77 figs., 3 pls. (1879).

Report on insects for the year 1881, U. S. Dept. Agr., Rept., 1881, pp. 209–214, pls. xix–xx (1882).

Report of the Dept. of Entomology, Cornell Agr. Expt. Sta., Dept. of Entom., 2d Rept., pp. 46–143, pls. i–iv (1883).

Evolution and taxonomy (Wilder Quarter-Century Book, 1893), pp. 34–114, pls. i–iii.

Insect life (New York, D. Appleton & Co., 1897, 1901), 349 pp., 296 figs., 18 pls.

A manual for the study of insects (Ithaca, N. Y., Comstock Pub. Co., 1894), 701 pp., 797 figs., vi pls. (five editions, last 1904).

The wings of insects (Ithaca, N. Y., 1899), 124 pp., 90 figs.

Wings of the Sesiidæ (in Mon. of Sesiidæ by Wm. Beutenmüller), Am. Mus. Nat. Hist., Mem. 1, p. 220 (1901).

How to know the butterflies: a manual of the butterflies of the Eastern United States (With Comstock, A. B.), (N. Y., Appleton, 1904), pp. xii + 311, 45 col. pls.

The spider book (Garden City, N. Y., Doubleday, Page & Co., 1918), 721 pp., 770 figs.

The wings of insects (Ithaca, N. Y., Comstock Pub. Co., 1918), 430 pp., 427 figs.

[55] *Calif. Fruit Grower*, vol. 10 (Jan. 2, 1892).

Nymphs, naiads and larvæ, Entom. Soc. Am., vol. 2, pp. 222–224 (1918).
An introduction to entomology (Ithaca, N. Y., Comstock Pub. Co., 1924), 1044 pp., 1228 figs.

Among the interesting and important California insects named by Comstock are the following:

Creosote lac scale, *Tachardiella larræ* (Comstock).
* Barnacle scale, *Ceroplastes cirripediformis* Comstock.
Oak wax scale, *Cerococcus quercus* Comstock.
* Chaff scale, *Parlatoria pergandei* Comstock.
Lintner's scale, *Chionaspis lintneri* Comstock.
Cottonwood scale, *Chionaspis ortholobis* Comstock.
Oak scale, *Chionaspis quercus* Comstock.
Cord grass scale, *Chionaspis spartinæ* Comstock.
Hemlock scale, *Aspidiotus pini* Comstock.
Walnut scale, *Aspidiotus juglans-regiæ* Comstock.
* San José scale, *Aspidiotus perniciosus* Comstock.
* Grape scale, *Aspidiotus uvæ* Comstock.
Coccid moth, *Lætilia cocidivora* Comstock.

Cook, Albert John [56] (Fig. 171). Born at Owosso, Michigan, August 30, 1842; died at the place of his birth, September 29, 1916. He received a broad training in agriculture and biology at the Michigan Agricultural College from which he graduated in 1862 and received the degree of Master of Science in 1864. After receiving his degrees he was instructor at Michigan from 1866–1868. From 1867–1868 he did graduate work at Harvard under L. Agassiz and H. A. Hagen and became Professor of Zoölogy at his own college in 1868. He also served as entomologist of the Agricultural Experiment Station 1888–1891. At Michigan, where the first period of his active life was spent, he was one of the early teachers of entomology and was an enthusiastic charter member of the American Association of Economic Entomologists which he served as one of the first officers, being second vice-president with

* Introduced into California.

[56] Goding, F. W., *Mich. Hort. Rept.*, vol. 18, pp. 338–339 (1888).
P. C. Jour. Entom., vol. 3, pp. 581–585, portrait (1911).
Calif. Blue Book or State Roster, 1911, p. 460 (1913).
Calif. Citrograph, vol. 1, p. 29, portrait (Nov., 1915); vol. 2, p. 11, portrait (Oct., 1916).
Crawford, D. L., *P. C. Jour. Entom. & Zoöl.*, vol. 8, pp. 169–170 (1916).
Entom. News, vol. 27, p. 432 (1916).
Calif. State Hort. Comm., *Mthly. Bul.*, vol. 5, p. 355, portrait (1916).
Pomona College Quarterly Mag. (Claremont, Calif.), vol. 5, pp. 11–15, portrait (1916); *ibid.*, pp. 185–187, portrait as frontispiece (1917).
Pacific Rural Press, vol. 92, p. 404 (Oct. 14, 1916).
Wade, J. S., *Ann. Entom. Soc. Am.*, vol. 21, p. 496 (1928).

S. A. Forbes as first vice-president and C. V. Riley as president, in 1889–1890. During this period he wrote eighteen bulletins at Michigan and published many articles in various entomological journals.

FIG. 171.—Albert John Cook (1842–1916) was one of the most inspiring and enthusiastic economic entomologists of this country. After leaving Michigan he did a great deal for the development of insect pest control, quarantine, and horticulture in California, having served as the third State Commissioner of Horticulture, 1911–1916. (This photograph was taken in Sacramento, California, in 1914.)

He early became interested in beekeeping and his Manual of the Apiary appeared in 1876. The 19th edition of this popular work appeared in 1910.[57] In all twenty-one thousand copies were sold. Shorter books on Silo and Silage, and Maple Sugar and the Sugar Bush also appeared during this period. The large bulletin on the birds of Michigan was a noteworthy contribution from his pen.[58] Here also he invented the Cook formula for kerosene emulsion in 1877 and demonstrated the use of arsenic (Paris green) for the control of the codling moth in 1880. He was the first to use the crude carbolic acid emulsion [59] in 1870 and carbon disulfide [60] as an insecticide in America in 1888 and 1890. He was in charge of Farmers' Club work in Michigan in 1875–1893.

The second period of his life began upon his removal to southern California in 1894 to accept the chair of Professor of Biology at Pomona College which position he retained until October, 1911. He at once became active among the fruit growers of California as a recognized leader, and was immediately given the Farmers' Insti-

[57] *The Beekeepers Guide or Manual of the Apiary* (Chicago, Geo. W. York & Co., ed. 19, 1910), 543 pp., 295 figs., portrait.

[58] Mich. Agr. Expt. Sta., *Bul. 94*, 148 pp., 109 figs. (1893).

[59] *Ibid., Bul. 58*, p. 8 (1890).

[60] *Ibid., Bul. 39*, pp. 11–12 (1888); *Bul. 58*, p. 10 (1890).
Hinds, W. E., U. S. Dept. Agr., *Farmers' Bul. 145*, p. 14 (1902).

tute and Club work of the University of California for the southern part of the state in 1894 and conducted the same for twelve years or until 1905. He organized eighty-nine farmers' clubs in the southern counties. The Claremont Pomological Club, the most noted and active of these, was organized in 1896 and celebrated its twenty-fifth anniversary session in 1921. Cook was for eighteen years the president and inspiration of the organization. With its help he assisted in the creation of farmers' telephone lines, insurance, coöperative exchanges, and the scientific study of orchard problems. He was also active in securing aid from the Bureau of Entomology in HCN fumigation investigations, begun in 1907. As a teacher of both botany and zoölogy he was a remarkable success, and in coöperation with C. F. Baker from 1908–1911, did some very splendid work training students in entomology. He was also responsible for securing the financial backing necessary for the Journal of Entomology, the Journal of Economic Botany, and the Report of the Laguna Beach Marine Laboratory.

Because of his recognized leadership in horticulture and insect pest control, he was appointed State Commissioner of Horticulture of California on October 21, 1911, by Hiram Johnson. He at once reorganized the quarantine, insectary, and executive departments, founded the Monthly Bulletin, and did everything in his power to make the office useful to the farmers of the state. In 1912 he exerted great influence and pressure to secure the passage of the national quarantine law which is of great importance to California and other agricultural states.

He published hundreds of articles in the California Cultivator, Pacific Rural Press, and other farm journals, and in the Monthly Bulletin of the California State Commission of Horticulture. One of his last important contributions was a small book on California Citrus Culture.[61]

During the last year of his life he suffered from an ailment which took him East for treatment, and failing a cure, he returned to his old home and to his son at Owosso and died at his birthplace. He was a man of sterling Christian character, of undying enthusiasm, dauntless optimism, unusual vigor and determination, exceptional magnanimity toward others, and a teacher who inspired students to outdo themselves. His motto was: *Truth*, that it would always

[61] *California State Commissioner of Horticulture* (Sacramento, 1913), 121 pp., 68 figs.

prevail; *Honesty*, in everything; *Work*, the supreme test of character and ability.

He was a member of the National Beekeepers' Association, British Beekeepers' Association, American Association for the Advancement of Science, Entomological Society of America, and American Association of Economic Entomologists.

For him, Howard named the wild grape seed chalcid, *Decatomidea cooki*, which were reared from grape seeds collected by Cook at Lansing, Michigan, March 12, 1884. This insect also infests the seeds of wild grape in California. The aphis, *Aphis cooki* Essig, was also named for him.

His personal library was presented to Pomona College in 1909 and, together with a large number of volumes presented by C. F. Baker at the same time, forms a part of the Cook-Baker Library.

Cooke, Matthew[62] (Fig. 172). Born at Bushmills, northern Ireland, February 16, 1829; died at Sacramento, California, August 25, 1887. California's first economic entomologist. As a youth he was engaged in the Public Works Department and became eventually Superintendent of Works. He emigrated to the United States in April, 1850, and moved to Sacramento, California, in October, 1862. After serving a time at the Water Works he became a progressive fruit box, berry basket, and chest manufacturer at Sacramento in 1875. The appearance of the codling moth in the apple orchards of the state and his liking for the study of natural history were responsible for his taking up the study of the insect with the view of preventing the injury to his business that was occurring due to a reduction of the apple crop by the new pest. With this object in view he studied entomology with great vigor and persistency, and, having a keen mind for the subject grasped it with unusual rapidity so that he was able to give an address before the State Fruit Growers at Sacramento, January 6, 1879. This address was followed by a series of press articles[63] and free pamphlets which at once brought Cooke forward as one who knew insect pests. Therefore, with the passage of the "Act to define and enlarge the duties and powers of the Board of State Viticultural Com-

[62] *Sacramento Daily Record-Union*, vol. 58 (Aug. 26, 1887), portrait (Aug. 28, 1887).
Goding, F. W., *West Coast Scientist*, vol. 7, pp. 27–29, portrait (1890).

[63] Some of these articles were signed Cooke and Son. One of these, *Progress of Insect Depredations*, appeared in the *Pacific Rural Press*, vol. 20, p. 248 (Oct. 16, 1880). Most of his articles first appeared in the *Sacramento Daily Record-Union*.

missioners, and to protect the interests of horticulture and viticulture" approved March 4, 1881, Matthew Cooke was appointed the first Chief Executive Horticultural and Health Officer of California in the same year. He at once formulated a set of six quarantine regulations,[64] against insects in general and fifteen rules directed against the codling moth. (See First Rept., State Bd. Hort., 1882.) As an exponent of insect pest control, Cooke became most efficient. He issued charts for schools and printed instructions for teachers, lectured throughout the state and exhibited a collection of insects at meetings and fairs. In order to further promote a knowledge of insects among the young he organized in Sacramento a band of boys into an institute for the purpose of studying insects. In 1881 he prepared and the state printed and circulated 10,000 copies of A Treatise on Insects Injurious to Fruit and Fruit Trees in California. It was quite elementary and contained 72 pages and 75 figures. On December 6 and 7 of the same year he called the First Annual Horticultural Convention at Sacramento, where he made an address and report and exhibited a collection of injurious insects and spraying equipment. His best work, Injurious Insects of the Orchard, Vineyard, etc.,[65] appeared in 1883. In the introduction he gives some important facts concerning early legislation to prevent the spread of injurious insects, early insecticides, codling moth, entomology in the public schools, beneficial and injurious

FIG. 172.—Matthew Cooke (1829–1887) was the first official economic entomologist in California and wrote the first books on insects published in the state. (After F. W. Goding, 1890.)

[64] C. A. Wetmore was appointed to a similar position as Chief Executive Viticultural and Health Officer the same year. He formulated quarantine regulations for the protection of the viticultural interests of the state. Thus these two men were the first to institute state quarantine regulations for the exclusion and control of insects.

[65] The complete title is, *Injurious insects of the orchard, vineyard, field, garden, conservatory, household, storehouse, domestic animals, etc., with remedies for their extermination* (Sacramento, H. S. Crocker & Co., 1883), 472 pp., 368 figs.

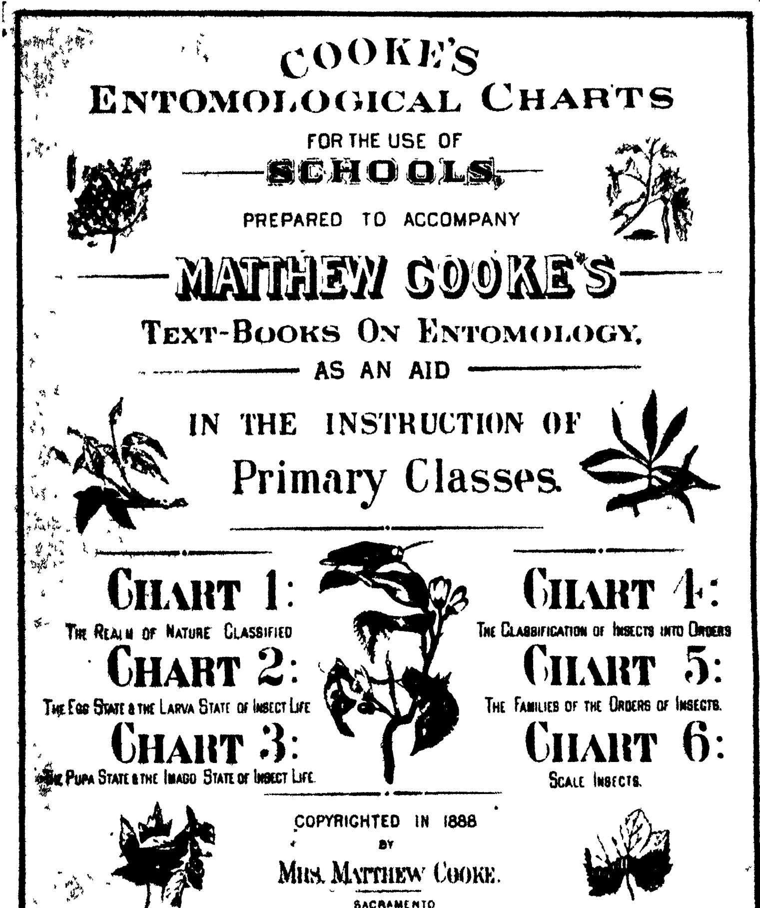

FIG. 173.—The title sheet of one of Matthew Cooke's Entomological Charts. The original is 20¾ x 26 inches, of good quality glazed paper on cloth and varnished. The top and bottom are bound with metal and the sides with narrow strips of red cloth. The seven sheets, including the title sheet and six charts, were suspended from a round black stick by means of two metal rings. (Photograph from original chart in possession of the Division of Entomology, Univ. of Calif.)

birds, etc. One hundred twenty-four remedies are included. Of the many illustrations used, fifty-one figures, and plates 1–4 are original, the remainder being taken from other well-known entomological works of the time.

The passage of an act in 1883 providing for a State Board of Horticulture, abolished the position held by Cooke and he failed to receive an appointment under the new board. Because of so much time spent in "public affairs, and in answering calls from all over the State to examine orchards and vineyards, he neglected his business and finally it failed on his hands." In 1884 he became horticultural and entomological editor of the Record-Union, Sacramento, Calif., which position he held until his death. He published more than 350 articles in the Record-Union, Pacific Rural Press, and other papers.

In recognition of his service to the fruit interests of the state a committee was appointed at the Eleventh State Fruit Growers' Convention, held at National City, Calif., April 16–19, 1889, "to secure a tomb for Matthew Cooke." The committee was granted further time to report at the twelfth convention to be held at Fresno, November 5–8, 1889.[66] The committee reported at this convention but as nothing was accomplished a new committee was appointed consisting of Wm. Johnston of Courtland, who reported for the old committee, McKinley of Los Angeles, and R. C. Kells of Yuba City.[67] Nothing further was done regarding the matter and nothing was given by the fruit growers of this great state to perpetuate the memory of one of their most worthy officials.

The following note regarding Cooke appeared as an editorial in the Sacramento Record-Union in 1880:

> Mr. Cooke is neither an agriculturist nor a scientific man, yet he has developed into a self-made naturalist, and he has already been enabled to confer great and permanent benefit upon the fruit growers of California. . . . It is by such unselfish and persistent inquiry and experiment that the most important discoveries are often made, and such self-taught naturalists as Mr. Cooke have frequently conferred more benefits upon their generation than more fully equipped scientists.

The cherry fruit sawfly, *Hoplocampa cookei* (Clarke) (*Dolerus*), was named for him by Warren T. Clarke.[68] The larva was first noted by Cooke in Solano County in 1883.

[66] State Board Hort. of Calif., *Ann. Rept.*, 1889, p. 441 (1890).
[67] State Board Hort. of Calif., *Ann. Rept.*, 1891, pp. 390–391 (1892).
[68] *Description of a new species of Sawfly*, Can. Entom., vol. 38, pp. 351–352 (1906).

Cooper, Ellwood [69] (Fig. 174). Born at Lancaster, Pennsylvania, May 24, 1829; died at his home in Ellwood near Santa Barbara, California, December 29, 1918, at the age of 89 years. He was of Quaker extraction and received the ordinary schooling of his time. Afterwards he was employed in a shipping house in Philadelphia engaged in the Brazilian trade. He conducted a trading business at Port-au-Prince, Haiti, for ten years, 1855–1865, and then moved to New York City where he took up a like occupation. He remained there until 1868, when, with his wife and son, he made a trip via Panama, to California. Much of the state he traversed by stage on a trip from San Diego to Portland, Oregon. He was so favorably impressed with the new region that in 1870 he quit New York and settled permanently in Santa Barbara County on a large estate which he named Ellwood Ranch, consisting of 2,000 acres and located twelve miles west of the town of Santa Barbara. Here he achieved much success in horticulture and soon became a leader in the state. He very early demonstrated the value of the eucalyptus; planted the first large commercial olive orchard in the state which consisted of 250 acres; was first to manufacture olive oil in the United States and invented his own machines for the purpose; planted 100 acres of English walnuts and a total of 1,000 acres of deciduous fruits; invented machines for hulling and pitting almonds and washing walnuts; and had a herd of 150 fine Jersey cows. In addition he was for three years president of Santa Barbara College.

He is characterized as "a man of broad, clear vision, of high conception, and a quiet, insistent nature that pursued a purpose to its end, and his advent into the horticultural affairs of this state created a turning point in the industry, and laid a solid foundation for the policy of recognition and protection pursued unto this day." A man of considerable wealth and leisure, he was able to participate in the broader aspects of horticulture and it is little wonder that he was selected as a member of the first State Board of Horticultural Commissioners of California in 1881 and a member of the first State Board of Horticulture in 1885, and served as the president of the latter from the time of its organization until it was replaced by a State Commissioner of Horticulture in 1903, which

[69] *Pacific Rural Press*, vol. 65, p. 273, portrait (May 2, 1903).
Hecke, G. H., Calif. State Com. Hort., *Mthly. Bul.*, vol. 8, portrait (frontispiece) (1919).

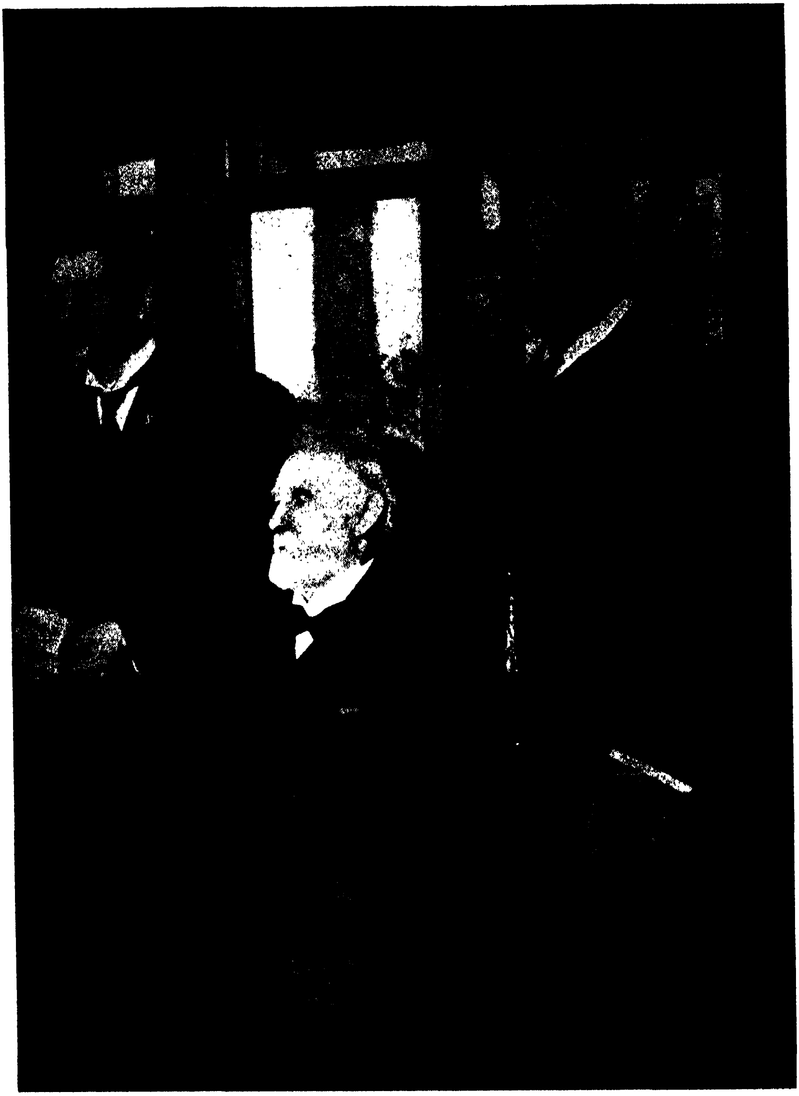

FIG. 174.—Ellwood Cooper (1829–1918), seated, was the first State Commissioner of Horticulture in California and an enthusiastic supporter of the biological control of insect pests. E. M. Ehrhorn, left, was then his chief horticultural quarantine officer, and George Compere, right, foreign collector of beneficial insects. Ehrhorn is holding one of the small cases used for rearing the codling moth parasite collected in Spain by Compere. (Photograph taken in the quarantine office, Ferry Building, San Francisco, in 1905.)

position he also held until 1907. He, more than any other man, laid the foundations of legislation in regard to the protection of horticulture. He was the foremost believer and promoter of the idea of biological or natural control of insects and after the successful introduction of the vedalia, the greater part of his life was devoted to the promotion of this phase of insect repression. He was also very much interested in horticultural quarantine, the inception and initial development of which occurred during his long administration of twenty-six years' service to the state. Many of the first trials with insecticides for the control of black scale were made in his extensive olive orchards. "One of the signal issues for which Cooper fought was the protection of our fruit products against competition with foreign labor and the securing of national pure food legislation which freed the olive oil from competition with adulterants and substitutes." Because he was a successful fruit-grower himself, he laid the foundations of horticulture with the hands of a master. If the great fruit interests of this state ever conceive the idea of erecting a monument to the one who has performed the greatest service for those interests, this monument should be to the memory and honor of Ellwood Cooper! One recalls with regret how this noble public servant was replaced by political processes and how his wounded pride made him a recluse during his last days and prevented his enjoying the larger rewards to which he was entitled.

In entomology, as in horticulture, he began as an amateur, and though he never gained the mastery of it as he did of the latter, yet he contributed much to this new science. He was an able and prolific writer and was a most convincing speaker.

Among his more important contributions to these two subjects may be mentioned the following:

Forest culture and eucalyptus trees (San Francisco, Cubery & Co., 1876), 204 pp., 2 figs.

A treatise on olive culture (San Francisco, Cubery & Co., 1882), 26 pp.

Diseases of the olive, Bd. of State Hort. Commrs., Calif., First Rept., pp. 35–40 (1882).

Annual addresses before the California State Fruit Growers' Convention held from 1885–1906. Much important information in these which constitute his most valued contributions.

Olive culture, Calif. State Bd. Hort., Third Bien. Rept., pp. 141–150 (1888); Rept. 1889, pp. 341–344 (1890).

Pruning and cultivation, *ibid.*, Rept., 1889, pp. 338–341 (1890).

Cooper, James Graham. Born in New York City, June 19, 1830; died in 1902. He graduated from the College of Physicians and Surgeons of New York in 1853 and soon afterwards received the appointment of physician and naturalist of the expedition under the leadership of General Isaac J. Stephens to explore a northern route for a railroad to the Pacific Ocean.[70] He became primarily interested in botany and published a number of investigations on trees.[71]

He had accompanied John L. LeConte, the great Coleopterist, to California in 1850. His association with LeConte and the entomologists at the California Academy of Sciences, of which he was an important member, resulted in the naming of a number of important insects for him. Cooper also collected bumblebees which were sent to John W. Greene.

Amphicoma cooperi (Horn) (California, Nevada, Oregon, Washington).
Lytta cooperi Lec. Syn. of *L. vulnerata* Lec.
Anthocharis cooperi Behr. syn. of *A. celthura* Feld.
Euphydryas cooperi (Behr).

Coquillett, Daniel William[72] (Fig. 175). Born near Woodstock, Illinois, January 23, 1856; died at Atlantic City, New Jersey, July 7, 1911. Buried at Marengo, Illinois, beside his parents. Eminent economic entomologist and dipterist. He was reared on a farm and received sufficient education to teach school. Early in life he became interested in biology and when twenty years old printed on a small hand press, with the help of his brother, a booklet on The Oölogy of Illinois, in which were described the eggs and habits of certain birds. Other articles followed in a local paper and his first real contribution to entomology entitled On the Early States of some Moths, appeared in the Canadian Entomologist, vol. 12, pp. 43–46 (1880). In response to a request from Cyrus Thomas, State Entomologist of Illinois, he prepared a more extended article on Larvæ of Lepidoptera for the Tenth Annual Report, State

[70] *Explorations for a route for a Pacific Railroad*, U. S. War Dept., Rept. 12 (1855).

[71] *On the distribution of the forests and trees of North America, with notes on its physical geography*, Smiths. Inst., Ann. Rept., 1858, Append., pp. 246–280 (1859).
On the forests and trees of Florida and the Mexican Boundary, *ibid.*, Ann. Rept., 1860, pp. 439–442 (1861).

[72] Cresson, E. T., Jr., *Entom. News*, vol. 22, pp. 337–338, portrait (1911).
Brues, C. T., *Psyche*, vol. 18, p. 159 (1911).
Hewitt, C. G., *Can. Entom.*, vol. 43, pp. 311–312 (1911).
Banks, N., et al., *Proc. Entom. Soc. Wash.*, vol. 13, pp. 195–210 (1911); *Ann. Entom. Soc. Am.*, vol. 5, p. 75 (1912).
Walton, W. R., *Jour. N. Y. Entom. Soc.*, vol. 22, pp. 159–164 (1914).
Wade, J. S., *Ann. Entom. Soc. Am.*, vol. 21, p. 496 (1928).

Entomologist of Illinois, pp. 145–186, figs. 51–79 (1881). He assisted Thomas in many ways and contributed a fundamental article on the army worm[73] which was a credit to him.

Fig. 175.—Daniel William Coquillett (1856–1911) was the outstanding early economic entomologist in California. He originated HCN fumigation for the control of scale insects on citrus trees, made known the poison bran mash for the control of grasshoppers, and later became one of America's greatest dipterologists. (From a photograph taken in 1889 and furnished by Professor Lawrence Bruner.)

Because of failing health, due to an attack of tuberculosis, Coquillett moved to southern California in 1882 and located at Anaheim where he soon recovered and again took up the study of insects. He collected in all orders and began to specialize on the Diptera although he continued to publish on widely different groups. His work won the approval of C. V. Riley who gave him an appointment as field agent of the Division of Entomology in 1885. During this same year he learned of a new method for the control of grasshoppers near Sacramento and at once investigated, with the result that he made known to the world the poison bran mash,[74] which has never been excelled as an insecticide for grasshoppers. This bait has also proved invaluable for the control of earwigs, cutworms, and similar mandibulate insects and for snails, sowbugs, and pillbugs. Coquillett substituted bran for middlings; otherwise the formula was materially the same as first used by the farmers in the Sacramento Valley in 1885. He also investigated the growing of pyrethrum and the manufacture of Buhach at Stockton, California, in 1885 and submitted to Riley a complete report[75] covering the same. But his chief work was in connection with the

[73] State Entom. Illinois, *Eleventh Ann. Rept.*, pp. 5–64 (1882).

[74] U. S. Commissioner of Agr., *Ann. Rept., 1885*, pp. 289–303 (1886).
Report on the locust invasion of California in 1891, U. S. Dept. Agr., Div. Entom., Bul. 27, pp. 34–57 (1892).

[75] *Production and manufacture of buhach*, U. S. Dept. Agr., Div. Entom., Bul. 12, pp. 7–16 (1885).

control of the cottony cushion scale, *Icerya purchasi* Maskell, which was spreading in alarming numbers throughout the citrus growing districts of the state. During 1886 he was dropped from the Division because of the lack of funds and privately experimented with hydrocyanic acid gas to control the scale. In 1887 he was again appointed by Riley and continued the work on HCN in coöperation with Alexander Craw and J. W. Wolfskill. The success of these investigations were published in 1887.[76] The work on fumigation continued and a number of reports were subsequently published on the same.[77] When it was thought that the cottony cushion scale might possibly be controlled by some natural enemy in its native home, Alexander Craw suggested sending Coquillett to Australia to secure the parasites. Riley, however, decided to keep Coquillett to handle the problems in California, and to send Albert Kœbele to Australia. This arrangement proved successful. The first shipment of the vedalia, *Rodolia cardinalis* (Mulsant), arrived in California, November 30, 1888, and the fifth and last lot on March 20, 1889.[78] These were promptly cared for and afterwards distributed into the orchards by Coquillett, who shares equally with Kœbele the honor of establishing the vedalia in California. During the period from 1884–1894 he made many important contributions to the economic entomology of the west. His papers were published in Insect Life,[79] the California Fruit Grower, the Pacific Rural

[76] *Report on the gas treatment for scale insects*, U. S. Comm. Agr., Ann. Rept., 1887, pp. 123–142 (1888).

[77] *Supplementary report on the gas treatment for scale insects*, Insect Life, vol. 1, pp. 41–42 (1888).

Gas treatment of Icerya, Pacific Rural Press, p. 313 (Oct. 13, 1888).

Improved methods in chemical fumigation, Calif. State Bd. Hort., Third Bien. Rept., pp. 174–177 (1888).

Hydrocyanic acid gas treatment for scale insects, Insect Life, vol. 1, p. 286 (1889).

Gas process for scale insects, *ibid.*, vol. 2, p. 122 (1889).

The use of hydrocyanic acid gas for the destruction of red scale, *ibid.*, vol. 2, pp. 202–207 (1890). Also *Sci. Am.*, Suppl., vol. 31, p. 1208 (May, 1890).

Fumigation for scale insects, Insect Life, vol. 3, p. 72 (1890).

History of hydrocyanic acid gas treatment for scale insects, *ibid.*, vol. 3, pp. 457–460 (1891).

Hydrocyanic acid gas as an insecticide, *ibid.*, vol. 4, pp. 176–180 (1893).

Patent on hydrocyanic acid gas process declared invalid, *ibid.*, vol. 7, pp. 257, 258 (1894).

[78] For a full discussion of the importations of the vedalia into California see the cottony cushion scale, p. 123.

[79] *Increased ravages of* Icerya *in California*, Insect Life, vol. 1, p. 110 (1888).

A California enemy of walnuts, *ibid.*, pp. 156, 157 (1888).

Corn-worm or boll-worm in California, *ibid.*, pp. 331–332 (1889).

The Australian ladybird, *ibid.*, pp. 377, 378 (1889); vol. 2, pp. 49, 70–74 (1889).

Re Lestophonus, *ibid.*, vol. 2, pp. 377–378 (1890).

Dipterous parasite of Diabrotica, *ibid.*, pp. 233–236 (1890).

Press, the Orange News, Rural Californian, West American Scientist and entomological journals and bulletins of the Division of Entomology.

His systematic work on Diptera began in 1886,[80] his first papers dealing chiefly with the Bombyliidæ. A number of other important works [81] on this family appeared while he was still in California. In 1893 he removed to Washington, D. C., to join there the staff of the Division of Entomology. His work from this time until his death was largely devoted to the systematic study of the Diptera and he became the leading dipterist of America. In 1896 he became honorary custodian of Diptera at the U. S. National Museum, which position he held until his death.

Coquillett was a tall, quiet, but energetic man who was well liked and who did a great deal to assist the younger entomologists of his time.

His splendid collection of Diptera went to the U. S. National Museum.

He published 258 separate papers, a number of which have already been cited. A complete list will be found in the first biographical reference. Some of the most important systematic papers are the following:

Revision of N. Am. Empidæ, U. S. Nat. Mus., Proc., vol. 18, pp. 387–440 (1895).

Cypress twig-borer, ibid., vol. 3, pp. 116–117 (1890).
A new scale insect from California, ibid., vol. 3, pp. 382–384 (1891).
California peach tree borer, ibid., pp. 392–393 (1891).
Notes on the habits of some California Coleoptera, ibid., vol. 4, pp. 260–262 (1892).
The dipterous parasite of Melanoplus devastator *in California, ibid.*, vol. 5, pp. 22–24 (1892).
Rept. on the Australian insects sent by Albert Kœbele to Ellwood Cooper and B. M. Lelong, ibid., vol. 5, pp. 251–254 (1893).
On the pollination of Yucca whipplei *in California, ibid.*, pp. 311–314 (1893).
Present status of the recent Australian importations, ibid., vol. 6, pp. 24–25 (1893).

[80] *Mon. of the* Lomatina *of N. Am.*, Can. Entom., vol. 18, pp. 81–87 (1886).

[81] *N. Am. genera of* Anthracina, Can. Entom., vol. 18, pp. 157–159 (1886).
N. Am. Species of Toxophora, Entom. Am., vol. 1, pp. 221–222 (1886).
Notes on the genus Exoprosopa, Can. Entom., vol. 19, pp. 12–13 (1887).
Mon. of the genus Anthrax *north of Mexico*, Trans. Am. Entom. Soc., vol. 14, pp. 159–182 (1887); Revision, *ibid.*, vol. 19, pp. 168–187 (1892).
Syn. of the N. Am. species of Lordotus, Entom. Am., vol. 3, pp. 115–116 (1888).
New Bombyliidæ from California, West Am. Sci., vol. 7, pp. 197–200 (1891).
New Bombyliidæ of the group Paracosmus, *ibid.*, pp. 219–222 (1891).
A revision of the bombylid genus Aphœbantus, *ibid.*, pp. 254–264 (1891).
Rev. of the bombylid genus Epacmus, Can. Entom., vol. 24, pp. 9–11 (1892).
Notes and descriptions of Bombyliidæ, ibid., pp. 123–126 (1892).
Rev. of the species of Anthrax *from America north of Mexico*, Trans. Am. Entom. Soc., vol. 19, pp. 168–187 (1892).

Revision of the Tachinidæ of America, North of Mexico, U. S. Dept. Agr., Div. Entom., Tech. Ser. 7, 154 pp. (1897).

The buffalo gnats or black flies of the U. S., ibid., Bul. 10, n. s., pp. 66–69, figs. 16–17 (1898).

Reports on the Californian and Nevadan Diptera, Invertebrata Pac., vol. 1, pp. 17–40 (1904).

A brief history of N. Am. dipterology, Proc. Entom. Soc., Wash., vol. 6, pp. 53–58 (1904).

A classification of the mosquitoes of North and Middle America, U. S. Dept. Agr., Div. Entom., Tech. Ser. 11, 31 pp. (1906).

Type species of N. Am. genera of Diptera, U. S. Nat. Mus., Proc., vol. 37, pp. 499–647 (1910).

A decision on Meigen's 1800 paper, Can. Entom., vol. 43, 66 pp. (1911). (His last paper.)

A few of the most important insects named by Coquillett are:

California green lacewing, *Chrysopa californica* Coq.
White sage mealybug, *Pseudococcus crawi* (Coq.).
Cypress mealybug, *Pseudococcus ryani* (Coq.).
Yucca mealybug, *Puto yuccæ* (Coq.).
Frosted scale, *Lecanium pruinosum* Coq.
Common mosquito, *Culex tarsalis* Coq.
California salt marsh mosquito, *Aëdes squamiger* (Coq.).
Yellow gnat, *Prosimulium fulvum* (Coq.).
Cottontail grub, *Cuterebra leporivora* Coq.
Rat grub, *Cuterebra tenebrosa* Coq.
Billbug tachina, *Myiophasia robusta* Coq.
Sawfly tachina, *Admontia hylotomæ* Coq.
Pine moth tachina, *Admontia retiniæ* Coq.
Oak moth tachina, *Thryptocera flavipes* Coq.
Cucumber beetle tachina, *Celatoria spinosa* Coq.
Codling moth tachina, *Lixophaga variabilis* (Coq.).
Semi-looper tachina, *Siphona plusiæ* Coq.
Erect tachina, *Phorocera erecta* Coq.
Caterpillar tachina, *Frontina armigera* (Coq.).
Sarcophaga davidsoni Coq.
opifera Coq.
Raspberry cane borer, *Phorbia rubivora* Coq.
Queensland fruit fly, *Dacus zonatus* Coq. (Not in North America.)
Melon fly, *Bactrocera cucurbitæ* (Coq.). (Not in North America.)
Baccharis gall fly, *Trypeta baccharis* Coq.
Bigelovia gall fly, *Trypeta notata* Coq.
Petroleum fly, *Psilopa petrolei* Coq.
Grass stem maggot, *Chlorops graminea* Coq.
Deer tick fly, *Lipoptena subulata* (Coq.).
Yucca mealybug parasite, *Anagyrus yuccæ* Coq.

Craw, Alexander [82] (Fig. 176). Born at Ayr, Scotland, August 3, 1850; died at Honolulu, H. T., June 28, 1908. Pioneer entomological quarantine officer. Craw emigrated to California in 1873 and after spending two years at San Diego, he moved to Los Angeles and assumed charge of the large J. W. Wolfskill orange grove in 1875. He was soon a recognized authority on horticultural and entomological subjects and became a leader in southern California. He assisted D. W. Coquillett in the investigations with HCN fumigation for the control of the cottony cushion scale in 1887–1888. He was the first to suggest the use of natural enemies for the subjugation of this pest and advocated sending Coquillett to Australia for the purpose.

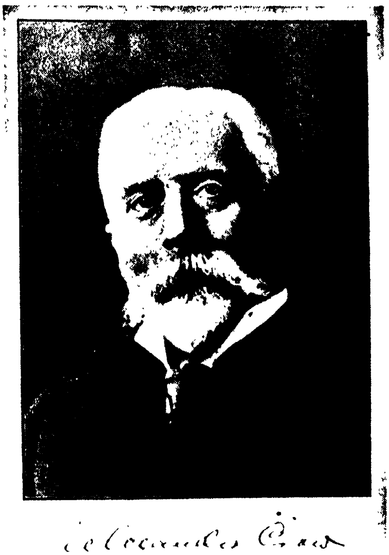

FIG. 176.—Alexander Craw (1850–1908) was a most efficient early California entomologist. He materially aided D. W. Coquillett in the HCN fumigating investigations and founded the plant quarantine service in California and in Hawaii. (After J. Kotinsky, 1908.)

In 1881 he made an insect exhibit at the Los Angeles Citrus Fair in September.[83] Inasmuch as this was probably the first exhibit of its kind ever made in California it will be of permanent interest to record the insects [84] which were displayed. They were:

1. Cottony maple or vine scale, *Pulvinaria vitis* (Linn.).
2. Soft brown scale, *Coccus hesperidum* (Linn.) (*Lecanium*).
3. Rose scale, *Aulacaspis rosæ* (Bouché) (*Diaspis*).
4. Glover's scale, *Lepidosaphes gloveri* (Packard).

[82] Kotinsky, Jacob, *Proc. Hawaiian Entom. Soc.*, vol. 2, pp. 24–26, portrait (1908); *Jour. Econ. Entom.*, vol. 1, pp. 410–411 (1908).
Swezey, O. H., et al., *Entom. News*, vol. 20, p. 48 (1909).
Wade, J. S., *Ann. Entom. Soc. Am.*, vol. 21, p. 497 (1928).

[83] *Pacific Rural Press*, vol. 22, p. 184 (Sept. 17, 1881).
In 1883 Matthew Cooke listed some 284 species of insects in his *Injurious insects of the orchard, vineyard, etc.*, but a considerable number of them did **not** occur in California.

[84] The names used by Craw, when not now accepted, are in parentheses.

5. Greedy scale, *Aspidiotus camelliæ* (Sign.) (*A. convexus* Comstock).
6. Walnut scale, *Aspidiotus juglans-regiæ* Comst.
7. Red scale, *Chrysomphalus aurantii* (Mask.).
8. Citrus mealybug, *Pseudococcus citri* (Risso).
9. Araucaria scale, *Eriococcus araucariæ* Mask. (*Uhleria*).
10. Cottony cushion scale, *Icerya purchasi* Mask.
11. Western twelve-spotted cucumber beetle, *Diabrotica soror* Leconte.
12. *Cotalpa lanigera* (Linn.). This beetle does not occur in California. He probably had *Pocalta ursina* (Horn) (*Cotalpa*).
13. Codling moth, *Carpocapsa pomonella* (Linn.).
14. Orange tortrix, *Tortrix citrana* Fernald.
15. California green lacewing, *Chrysopa californica* Coq.
16. *Reticulitermes flavipes* (Kollar) (*Termes*). Probably not this species.
17. Angular-winged katydid, *Microcentrum rhombifolium* (Sauss.) and eggs.
18. Common red spider, *Tetranychus telarius* (Linn.), or more likely the two-spotted mite, *T. bimaculatus* Harvey.

Because of his knowledge of insects, Craw was appointed quarantine inspector at the port of San Francisco in 1890 by the State Board of Horticulture, and it was he more than anyone else, who conceived and put into practice the working principles of horticultural quarantine as it is today. He remained in San Francisco until 1904 when he accepted a much more remunerative position as Superintendent of Entomology and Inspector of the Hawaiian Board of Agriculture and Forestry at Honolulu. Here he established a similar system of protective quarantine for the Hawaiian Islands and remained until his death in 1908.

Craw was not an extensive writer and most of his papers were fragmentary in subject matter. Of his more interesting papers may be mentioned:

Insect pests and their extermination—parasites and fungous diseases, State Bd. Hort., Calif., Ann. Rept., 1891, pp. 284–288 (1892).

Destructive insects, their natural enemies, remedies and recommendations, *ibid.*, Div. Entom., pp. 1–51, figs. 1–62 (1891). [Desc. of *Aspidiotiphagus citrinus* (Craw), pp. 28–29.]

Report of Quarantine Officer and Entomologist, *ibid.*, Fourth Rept., 1893–1894, pp. 79–109 (1894). (Desc. of *Physokermes insignicola* Craw, pp. 92–93.)

Introducing and fostering beneficial insects, Rept. 18th Calif. State Fruit Growers' Conv., pp. 105–108 (1895).

Injurious insect pests found on trees and plants from foreign countries, State Bd. Hort., Calif., 5th Bien. Rept., 1895–1896, pp. 33–52, pls. vi–viii (1896).

Insect pests and tree diseases liable to be introduced into the state, and especially to be guarded against, *ibid.*, pp. 23–27 (1896).

Entomology and quarantine, *ibid.*, pp. 127–135 (1896).

Dangerous pests quarantined by the State Board of Horticulture, Rept. 24th Calif. State Fruit Growers' Conv., pp. 79–86 (1900).

What California has done for horticulture, *ibid.*, 26th Conv., pp. 160–165 (1902).

Fruit flies and their exclusion, *ibid.*, 28th Conv., pp. 94–97 (1903).

Friendly insects, *ibid.*, 29th Conv., pp. 142–148 (1904).

He named two common California insects, the Monterey pine scale, *Physokermes insignicola* Craw, and the scale parasite, *Aspidiotiphagus citrinus* (Craw) (*Coccophagus*).

For him Coquillett named the white sage mealybug, *Pseudococcus crawi* Coq., and the diabrotica parasite, *Celatoria crawi* Coq., which proves to be a synonym of *C. diabroticæ* Shimer. Other insects named for him are:

* Cottony bamboo scale, *Antonina crawi* Ckll.
* *Aulacaspis crawi* Ckll. (Not established in California.)
* *Lepidosaphes crawi* Ckll. (Not established in California.)

His material, left with the State Board of Horticulture, was destroyed by the earthquake and fire in 1906.

Cresson, Ezra Townsend[85] (Fig. 177). Born at Byberry, Pennsylvania, June 18, 1838; died at the residence of his son E. T. Cresson, Jr., at Swarthmore, Pennsylvania, April 19, 1926, in his eighty-eighth year. Pioneer American Hymenopterist. The Entomological Society of Philadelphia, which was the first of its kind in America, was organized at his residence on February 22, 1859, through his own efforts and those of James Riddings[86] and Thomas B. Wilson. The name of this organization was changed to the American Entomological Society on February 11, 1867. He was recording secretary in 1855, corresponding secretary sixteen years, 1859–1874, curator eight years, 1866–1874, editor of the

Cresson was the greatest American general hymenopterist and laid the foundations for the study of the large and difficult order. He wrote a great many papers, the most important ones being:

Catalogue of the described species of N. Am. Hymenoptera, Proc. Entom. Soc., Phila., vol. 1, pp. 227–238 (1862); pp. 316–344 (1863).

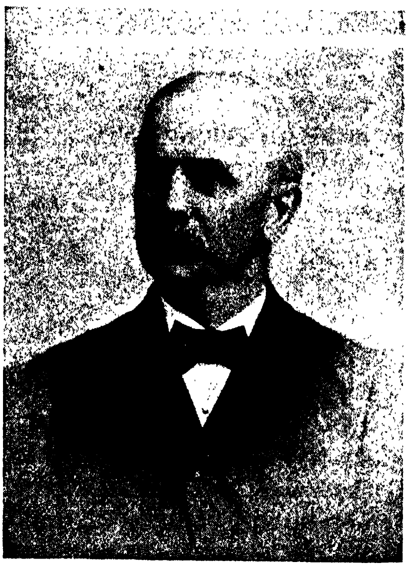

FIG. 177.—Ezra Townsend Cresson (1838–1926) was the pioneer American hymenopterist and one of the ablest exponents of entomology in the country. A very great many of our important Hymenoptera were described by him. (Photograph taken about 1890 furnished by Dr. L. O. Howard.)

Catalogue of N. Am. Apidæ, Trans. Am. Entom. Soc., vol. 7, pp. 215–232 (1878–1879).

Monograph of the Philanthidæ of N. Am., Proc. Entom. Soc. Phila., vol. 5, pp. 85–132 (1865).

A list of the Ichneumonidæ of N. Am., Trans. Am. Entom. Soc., vol. 1, pp. 289–312 (1867); vol. 2, pp. 89–114 (1868–1869); vol. 6, pp. 129–212 (1877).

Synopses of the families and genera of the Hymenoptera, north of Mexico, together with a catalogue of the described species and bibliography, I, Trans. Am. Entom. Soc., Supplm. (1887); II, *ibid.*, supplm. (1887).

Catalogue of the Tenthredinidæ and Uroceridæ of N. Am., Trans. Am. Entom. Soc., vol. 8, pp. 53–68 (1880).

The Cresson types of Hymenoptera, Mem. Am. Entom. Soc. (1916).

Cresson's large collection, containing types of at least 2,737 species, is in the Philadelphia Academy of Sciences in the care of his son, E. T. Cresson, Jr., Curator of the American Entomological Society.

Some of the Hymenoptera of importance to the West named by Cresson are:

Pontania parva (Cresson).
Pacific sawfly, *Cimbex pacifica* Cresson.
Abia americana (Cresson).
Western horntail, *Sirex areolatus* (Cresson).
Behrens' horntail, *Sirex behrensi* (Cresson).
Morrison's horntail, *Xeris morrisoni* (Cresson).

Western oryssus, *Oryssus occidentalis* (Cresson).
Microplitis croceipes (Cresson).
Meteorus communis (Cresson).
dimidiatus (Cresson).
vulgaris (Cresson).
Chelonus iridescens Cresson.
Lysiphlebus testaceipes (Cresson).
Syrphoctonus pacificus (Cresson).
maculifrons (Cresson).
Xorides californicus (Cresson).
insularis (Cresson).
Deuteroxorides borealis (Cresson).
Pœmenia americana (Cresson).
Polysphincta texana Cresson.
Megarhyssa nortoni [87] (Cresson).
Tromatobia rufopectus (Cresson).
Ephialtes pedalis (Cresson).
sanguinipes (Cresson).
Itoplectis behrensi (Cresson).
Itamoplex tejonensis (Cresson).
Amblyteles subfuscus Cresson.
Spilochalcis flavopicta (Cresson).
torvina (Cresson).
Western harvester ant, *Pogonomyrmex occidentalis* (Cresson).
Ellampus læviventris (Cresson).
Hedychridium dimidiatum (Say).
Hexachrysis clara (Cresson).
Parnopes edwardsi Cresson.
Chlorion læviventris (Cresson).
Sphex vulgaris (Cresson).
Mutilla aureola Cresson.
sackeni Cresson.
Pseudomethoca propinqua (Cresson).
Psammochares luctuosus (Cresson).
Polistes bellicosus Cresson.
flavus Cresson.
texanus Cresson.
Anthidium illustre Cresson.
The mason bee, *Andronicus productus* (Cresson).
California carpenter bee, *Xylocopa californica* Cresson.
Mountain bumblebee, *Bremus appositus* (Cresson).
Edward's bumblebee, *Bremus edwardsi* (Cresson).
Pale-faced bumblebee, *Bremus flavifrons* (Cresson).
Mixed bumblebee, *Bremus mixtus* (Cresson).
Nevada bumblebee, *Bremus nevadensis* (Cresson).
Psithyrus variabilis Cresson.

[87] Named for the eminent American authority of the Tenthredinoidea, Edward Norton.

Crotch, George Robert[88] (Fig. 178). Born at Cambridge, England, in 1842; died at Philadelphia, Pennsylvania, June 16, 1874, at the age of thirty-two years.

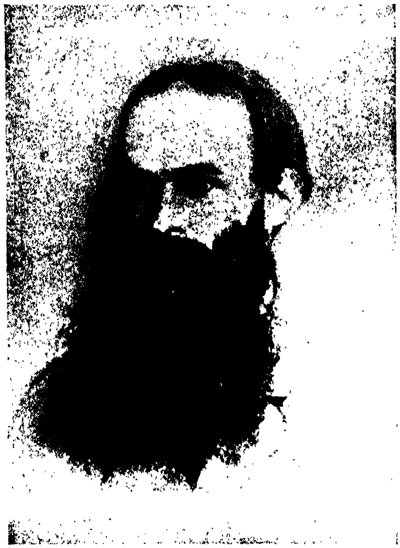

Fig. 178.—George Robert Crotch (1842–1874), a coleopterist of note, who died at the threshold of his career. He collected insects in the West in 1873 and has named a number of important ladybird and other beetles. (Photograph furnished by Dr. L. O. Howard.)

Crotch became interested in entomology when still an undergraduate at the University of Cambridge and was engaged in making a collection of Lepidoptera and Coleoptera, but by the time he obtained his M. A. degree in 1863, he was devoting his attention entirely to the Coleoptera and in that year he published a Catalogue of British Coleoptera, which attracted much attention. In 1864 he collected in the Canary Islands and on his return to England accepted an appointment in the Library at Cambridge. He was a most successful collector and spent all of his leisure time in studying beetles. In 1866 he revised the Catalogue of British Coleoptera. In 1865 and again in 1870 he visited Spain and published a list of the Coleoptera of the Azores in 1867,[89] and in 1870[90] he issued a list of all the Coleoptera of the group Adephaga described between 1758–1821. Up to this time he had also published a number of other valuable papers, and was an authority on the Coccinellidæ and Erotylidæ of the world, and was a sub-editor of the Zoölogical Record.

[88] Edwards, Henry, *A tribute to the memory of G. R. Crotch*, Calif. Acad. Sci., Proc., vol. 5, pp. 332–334 (1874).
Kraatz, G., *Berlin Entom. Zschr.*, vol. 18, p. 7 (1874).
Bethune, C. J. S., *Can. Entom.*, vol. 6, p. 160 (1874).
Nat. Can., vol. 6, p. 269 (1874).
Entom. Mthly. Mag., vol. 11, pp. 70–72 (1874).
Am. Naturalist, vol. 8, p. 512 (1874).
Wade, J. S., *Ann. Entom. Soc. Am.*, vol. 21, p. 497 (1928).
Horn, W., and Schenkling, S., *Index Litt. Entom.*, vol. 4, p. 1388 (1929).
[89] *Proc. Zoöl. Soc. London*, pp. 359–391 (1867).
[90] *Trans. Entom. Soc. London*, vol. 1, pp. 41–52, 213–214 (1870).

In the autumn of 1872 he left England for the purpose of making an entomological tour of the world, arriving at Philadelphia in 1872 and in California in the spring of 1873. The summer was spent in collecting in California, Oregon, and the Fraser River in British Columbia. While in California he was most successful in his work and became acquainted with Henry Edwards and others at the California Academy of Sciences. In California he collected extensively at Crystal Springs on Crystal Springs Lake, now in the Spring Valley Water Company's preserve in San Mateo County. The old resort was destroyed when the property was taken over for a water storage basin.

He returned to Philadelphia in the fall of 1873 and had accepted an appointment from L. Agassiz to take charge of the insects at the Cambridge Museum of Comparative Zoölogy when he was stricken with consumption, acquired through exposure, and succumbed the next spring. Before he died he wrote to Henry Edwards at San Francisco: " Please keep my net and use it—it will be long before I need it again."

> Crotch was a man of genial and courageous disposition, and to such of us as have lost in him a friend as well as the entomologist, the loss is indeed a grievous one. His powers of work were enormous, and there can be no doubt that he often (we might say habitually) overtaxed himself; he really appeared to have no thought of taking care of himself, and it is no doubt due to these things, in conjunction with the trying climate of the United States during the winter, that the development of the illness which has deprived us of him is to be attributed. He was, we believe, only thirty-three (32) years of age, and was cut off at the moment when his faculties might have been expected to have taken a still higher development; had his judgment matured and become equal to his powers, he would have ranked amongst the very first of the entomologists of the world.[91]

His collection of Coleoptera from the Azores is now at the British Museum, London, and the European Coleoptera, the Erotylidæ and Coccinellidæ are at the Museum of Comparative Zoölogy, Cambridge, Mass.

His important papers published in America are:

Materials for the study of Phytophaga of the United States, Acad. Nat. Sci., Phila., Proc., vol. 25, pp. 19–83 (1873).

Notes on the species of Buprestidæ found in the United States, *ibid.*, pp. 84–96 (1873).

[91] *Entom. Mag.*, vol. 11, p. 72 (1874).

Synopsis of the Erotylidæ of Boreal America, Trans. Am. Entom. Soc., vol. 4, pp. 349–358 (1873).

Synopsis of the Endomychidæ of the United States, *ibid.*, pp. 359–363 (1873).

Revision of the Coccinellidæ, *ibid.*, pp. 363–382 (1873).

Revision of the Dytiscidæ of the United States, *ibid.*, pp. 385–424 (1873).

On the arrangement of families, Am. Philos. Soc., Proc., vol. 5, pp. 75–87 (1873).

Check List of the Coleoptera of America north of Mexico (Salem, Mass., Naturalists' Agency, 1873), 134 pp.

Among some of the important species of beetles described by Crotch are the following:

Termitophilus silphid beetle, *Platycholeus leptinoides* (Crotch).
Bidessus plicipennis (Crotch).
Hydroporus addendus Crotch.
Agabus intersectus (Crotch).
    lecontei (Crotch).
Dicerca horni Crotch.
    sexualis Crotch.
Agrilus walsinghami Crotch.
Hyperaspis horni Crotch.
Scymnus pacificus Crotch.
    phelpsi Crotch.
Adalia annectans Crotch.
Neomysia horni (Crotch).
Phyllotreta oregonensis (Crotch).
    ramosa (Crotch).
Fuller's rose weevil, *Pantomorus godmani* (Crotch).

Davidson, Anstruther. Born at Caithness, Scotland, February 19, 1860; at present associate professor of dermatology at the College of Medical Evangelists, Los Angeles. He received the degrees of M. B. and C. M. at the University of Glasgow in 1881 and M. D. in 1887. He came to Los Angeles from Scotland in 1889 and was a practicing physician until he became associate professor of dermatology at the University of Southern California at Los Angeles in 1909. He also held a similar position at the College of Physicians and Surgeons in the same place.

He was one of the early naturalists of southern California and Arizona being particularly interested in botany and entomology. He early became a fellow of the Southern California Academy of Sciences, having been president in 1893 and editor since 1902 and a corresponding member of the Philadelphia Entomological Society.

Among the papers contributed by him from Los Angeles may be mentioned:

The nest and parasites of Xylocopa orpifex *Smith*, Entom. News, vol. 4, pp. 151–153 (1893).

On the parasites of wild bees in California, ibid., vol. 5, pp. 170–172 (1894).

The habits of California bees and wasps, ibid., vol. 6, pp. 252–253 (1895).

Habits and parasites of Stigmus inordinatus *Fox*, Psyche, vol. 7, pp. 271–272 (1895).

On the nest and parasites of Prosopis varifrons *Cresson, ibid.*, pp. 315–316 (1895).

Habits and parasites of a new Californian wasp, ibid., pp. 335–336 (1895).

On the nesting habits of Anthidium consimile, Entom. News, vol. 7, pp. 22–26 (1896).

Alcidamea producta *Cress. and its parasites, ibid.*, vol. 7, pp. 216–218 (1896).

Parasites of spider eggs, ibid., vol. 7, pp. 319–320 (1896).

He later wrote from Clifton, Arizona, where he continued his entomological studies,[92] and again in 1902 he was in Los Angeles. His later papers on insects are:

An enemy of the trap door spider, Entom. News, vol. 16, p. 233 (1905).

Beetles from bee cells, Entom. News, vol. 18, p. 446 (1907).

He also published in the *Bulletin of the Southern California Academy of Sciences* an article on the kissing bug (1903); the Bremidæ of southern California (1910), *Masara vespoides* (1913), and termites (1917).

In botany he published:

Plants of Los Angeles County (1892), 36 pp.

Flora of southern California (1893), 452 pp.

Ashmead named the parasite, *Hemiteles davidsoni* and Coquillett the fly, *Sarcophaga davidsoni*, for him.

DeGeer, Carl[93] (Fig. 179). Born in Finspang, Sweden, February 10, 1720; died in Stockholm, March 8, 1778. DeGeer was a member of a wealthy and noble family, possessing valuable iron mines and steel mills. He was educated in Holland and later became a pupil of the great Linnæus, and, like his teacher, he became celebrated

[92] See notes in *Entom. News*, vol. 10, pp. 179–181 (1899); vol. 11, pp. 510–511 (1900).

[93] Bergmann, Torbern Olof, *Ammnelse-tal ofver Kgl. Mjts.* Tro-Man Hr. C. DeGeer, Stockholm, vol. 8, p. 40 (1779).

Swainson, W., *Bibliogr. of Zoöl.*, pp. 194–197 (1840).

Hagen, H. A., *Bibliot. Entom.*, vol. 1, pp. 265–267 (1862).

Miall, L. C., *Natural hist. of aquatic insects* (London, Macmillan, 1895), pp. 362–364; *Early naturalists—their lives and work* (London, Macmillan, 1912), pp. 277–278, 305.

Berlese, A., *Gli insetti* (Milano, Kramer, 1909), vol. 1, p. 23.

Dow, R. P., *Bul. Brooklyn Entom. Soc.*, vol. 8, p. 38 (1913).

Wade, J. S., *Ann. Entom. Soc. Am.*, vol. 21, p. 497 (1928).

Horn, W., and Schenkling, S., *Index Litt. Entom.*, vol. 1, pp. 247–249 (1928).

as a naturalist and entomologist. He was one of the first great students of the life histories and economics of insects and his system of classification, by wings and mouth parts, was far in advance of anything before his time. His entomological studies were printed in twenty papers, of which the most important are the Mémoirs pour servir à l'histoire des Insectes.[94] Stockholm. T. i (1752) to T. vii (1778). In these he followed the works of Réaumur.

Fig. 179.—Baron Carl DeGeer (1720–1778), a contemporary of Linnæus, named a great many important economic insects which occur throughout this country.

His collection is in the Museum of Stockholm.

DeGeer did some excellent entomological work, but a comparison of his list of common insects with those of Linnæus and Fabricius will show that he came far short of the two greatest entomologists of his time. Many of the species described by him were suppressed because they appeared before the Tenth edition of Linnæus' Systema Naturæ, 1758.

The following mites and insects were named by DeGeer:

* Flour mite, *Aleurobius farinæ* (DeGeer).
Red-legged locust, *Melanoplus femur-rubrum* (DeGeer).
Snowy tree cricket, *Œcanthus niveus* (DeGeer).
Striped ground cricket, *Nemobius fasciatus* (DeGeer).
* Biting dog louse, *Trichodectes canis* DeGeer.
* Head louse, *Pediculus capitis* DeGeer.
* Body louse, *Pediculus corporis* DeGeer.
* Green apple aphis, *Aphis pomi* DeGeer.
* Squash bug, *Anasa tristis* (DeGeer).
† *Harpalus pennsylvanicus* DeGeer.
* Red-legged ham beetle, *Necrobia rufipes* (DeGeer).
Muck or carrot beetle, *Ligyrus gibbosus* (DeGeer).
Common snow mosquito, *Aëdes communis* (DeGeer).
Mantis fly, *Ochthera mantis* (DeGeer).

* Introduced into California.
† DeGeer named at least twenty-two species of American Coleoptera.

[94] "His first volume found so few purchasers that DeGeer in a fit of disgust burned a large part of the edition; this volume has been scarce ever since." Miall, L. C., *loc. cit.*, p. 278 (1912).

Dejean, Pierre François Marie Auguste[95] (Fig. 180). Born in Amiens, France, August 10, 1780, and died in Paris, March 17, 1845. He was the greatest coleopterist of his time and his name is attached to a very great number of our commonest western beetles, which he received directly from J. F. Eschscholtz and from collectors the world over. After his return from the second voyage round the world, Eschscholtz visited Dejean at his home in Paris, and worked with him for a brief time. With him he left duplicates of most of the species which he had collected in America. Many of these had manuscript names attached to them, but due to the premature death of Eschscholtz, the original descriptions were never published by the latter. Dejean used Eschscholtz's names and descriptions giving him full authorship in his works, but inasmuch as the descriptions were published by Dejean he has been given priority and therefore his name is attached to most of the North American species collected by Eschscholtz in 1824.

FIG. 180.—Count Pierre François Marie Auguste Dejean (1780–1845) described Coleoptera from many parts of the world and named many from the collection of J. F. Eschscholtz, which were taken in California by the early Russian collectors. (After J. A. Boisduval, 1845.)

Dejean was a soldier of fortune throughout the Napoleonic wars

[95] Boisduval, J. A., *Ann. Soc. Entom. France* (2), vol. 3, pp. 499–520, portrait (1845).
Swainson, W., *Bibliog. of Zoöl.*, p. 167 (1840).
Hagen, H. A., *Bibliot. Entom.*, vol. 1, pp. 165–166 (1862).
Kraatz, G., *Berl. Entom. Zeit.*, vol. 18, pp. 138, 143–145 (1874).
Marseul, S. A. de, *L'Abeille*, vol. 21, pp. 60–63 (1883).
Dow, R. P., *Bul. Brooklyn Entom. Soc.*, vol. 8, pp. 39–40 (1913); vol. 9, pp. 10–13, 37–39 (1914).
Wade, J. S., *Ann. Entom. Soc. Am.*, vol. 21, p. 497 (1928).
Horn, W., and Schenkling, S., *Index Litt. Entom.*, vol. 1, pp. 249–251 (1928).

and finally rose to the rank of Lieutenant General and aide-de-camp to Napoleon. An indefatigable collector by nature, he never ceased adding to his collections even during the battles and he added a few from the field of Waterloo. After the wars he collected in Austria, and, by exchange, by purchase, and by friendly gifts and by sending out collectors, soon had the greatest collection of Coleoptera in the world, which drew to him the most distinguished entomologists then living. Among his immediate associates were Guillaume Antoine Olivier (1756–1814), Pierre André Latreille (1762–1833), whom he specially befriended and helped, and Jean Baptiste Pierre Antoine de Monet Lamarck (1774–1892), all of whom became famous naturalists. John E. LeConte (1784–1860) was also a warm friend and sent him some 800 species of Coleoptera from Georgia.

Dejean was the first great amateur collector, but was neither an anatomist nor a philosopher and therefore left little of a fundamental nature in classification, but his work was thorough and sound for his day and stood the test of time in a very satisfactory way. His great specialty was the Carabidæ of the world of which he described no less than 40 valid species from California. Of the very many western species described by him, we should, perhaps, call attention to the following:

The snail eater, *Scaphinotus ventricosus* (Dej.).
The California pterostichus, *Pterostichus californicus* (Dej.).
The rufous carabid, *Calathus ruficollis* Dej.
The tule beetle, *Platynus maculicollis* (Dej.).
The malodorous carabid, *Nomius pygmæus* (Dej.).
Amara insignis Dej.
Pristonychus complanatus Dej.

His collection numbered 22,399 species in 1837. It has been divided and has passed through the hands of many famous coleopterists including R. Oberthur, L. J. Reiche (whose collection is in many places, but chiefly with Oberthur), F. Godman, and O. Salvin (British Museum). Portions are at the Museum at Turin, Museum at Lyon, Museum at Barcelona, and many others.

Dejean published 15 works, the most important of which was his great *Catalogue des Coléoptères de la collection de M. le Comte Dejean.* Four Editions: I, 11 pp. (1802); II, 176 pp. (1833); III, 443 pp. (1836); IV, pp. 124–131 (1836). (Edition III contains descriptions of the species collected and described by Eschscholtz.)

Dunn, George W. (Fig. 201). Born in the state of New York, May 18, 1814; died in San Francisco in 1905, at ninety-two years of age. He was elected a resident member of the California Academy of Sciences, March 16, 1874. Mrs. L. E. Ricksecker, in a letter to me dated March 18, 1927, at San Francisco, Calif., has the following comments on George Dunn:

> Dunn was collecting seeds for the government all over the state (California) and in Arizona and New Mexico. He collected Coleoptera in bulk and sent them to Mr. Ricksecker to sell on commission, but he was not an entomologist, and like the rest of the collectors, knew very little about his catch. He was an eccentric but indefatigable collector and would climb a couple of hundred feet up pine trees when he was past eighty. It was he who put lengths of stove pipe on his legs in places frequented by rattlesnakes. He was chased by Apaches, but allowed to escape when they saw him digging larvæ out of a rotten log and concluded he was a big medicine man. They accepted some mashed larvæ as a medicine, and showed him where he could find more, but he added: "I did not go back; the next bunch may have been more civilized."

Dow[96] states that "he was a genial soul, always on his uppers, who collected insects, plants, shells, anything else he could sell. Like Micawber, he waited for something to turn up. He was admitted into the almshouse in San Francisco, August 24, 1904, and left of his own accord on December 23, 1904. Beetles were named for Dunn by J. J. Rivers and T. L. Casey."

Dunn collected in Mexico, throughout California, and Oregon. He published two lists of beetles in Zoe.[97]

Dwinelle, Charles Hascall (Fig. 181). Born at Rochester, N. Y., March 28, 1847; at present state licensed real estate broker and insurance agent, living at 1026 McDonald Ave., Santa Rosa, California. He was educated by private tutors and in the Collegiate Institute at Rochester and, after coming to California in 1863, in the Oakland College School and McClure's Academy at Oakland. He graduated from the Sheffield Scientific School of Yale College with the degree of Ph. B. in 1871. While a student there he spent the summer of 1870 with A. E. Verrill at the Bay of Fundy, Me., studying marine life. Upon his return to California he engaged in mixed farming and animal husbandry, seven years after which he was appointed lecturer on practical agriculture and entomology and supervisor of field experiments at the College of Agriculture, Uni-

[96] Dow, Robert P., footnote, *Psyche*, vol. 9, p. 69 (1914).
[97] *Zoe*, vol. 2, pp. 152–154, 310–312 (1891).

versity of California, from 1878–1885. During this period he had a marked influence upon the future development of agriculture and related sciences in California. His first lecture at the University of California delivered in 1878 was entitled Science and Agriculture.[98]

FIG. 181.—Charles Hascall Dwinelle (1847–   ) was the first instructor in entomology in California and he did much to establish a professorship in that science at the University of California. (This photograph, taken in 1883, was loaned by Mr. Dwinelle, who is still active and very much interested in this book.)

On April 5, 1881, the Board of State Viticultural Commissioners organized an Advisory Board of Horticulture consisting of eleven members. Dwinelle was chosen a member at large and elected the first president of the Board, which position he held until the creation of the State Board of Horticulture in 1883. As president of this organization he presided at the first California State Fruit Growers' Convention called by Matthew Cooke by order of the Board of State Horticultural Commissioners, in the State Capitol, Sacramento, December 6, 1881,[99] and also at the second convention held in San José, November 14, 1882. At this time also he gave some lectures on entomology at the University of California. Although there were no special courses preparatory to teaching this subject when he attended Yale, yet he had obtained a sufficient amount of entomological information to place him far ahead of any of his associates in California in this particular field and it was soon a custom to refer all problems of an entomological nature to him. The importance of this new science so impressed him that he initiated a move to secure a professorship of ento-

[98] *Pacific Rural Press*, vol. 16, p. 293 (Oct. 9, 1878).
[99] His opening address appeared in California Fruit Growers' Conv., *Rept.*, 1882, pp. 5–7 (1882).

mology at the University of California and fill the position with a thoroughly trained entomologist. Accordingly at the third fruit growers' convention held in San Francisco, November 21, 1883, he presented a paper entitled, The Need of a General Knowledge of Insects, [100] and urged a popular subscription of $50,000 to endow a chair of entomology at the University and offered $500 as a personal contribution. Judge Blackwood of Hayward offered a like amount, but the committee appointed to take charge failed to go further with the recommendation.

Articles on this subject later appeared in the agricultural press [101] and in 1884 he was employed to give instruction in entomology to the students of the College of Agriculture [102] and thus became the first teacher of entomology in an institution of higher learning in California. On September 11, 1884, he issued a statement [103] regarding the situation, emphasizing much that he had previously published. In this article he called attention to the entomological problems and the work of E. W. Hilgard and F. W. Morse on the grape phylloxera; the need of instruction in economic entomology to students in the College of Agriculture; the purchase of the Ricksecker collection of beetles for $400; the preparation of teachers to meet the demands for teaching entomology in the public schools; and recommended the endowment of a professorship in entomology.

During the period 1884–1885 he was also editor of the Cultivator's Guide, a bi-monthly published by Weinstock-Lubin at Sacramento.

On July 8 and 9, 1885, he was a delegate of the California Agricultural Experiment Station to the convention of delegates from agricultural colleges and experiment stations held at the U. S. Department of Agriculture, Washington, D. C.

In 1885–1886 he was given a year's leave of absence from the University of California and with his wife traveled through various parts of the United States and Europe, including in the latter the British Isles, France, Italy, Switzerland, Germany, and Austria. Upon his return to California he found that his health did not justify his assuming his former position. Although afterwards he was twice offered an appointment to the university faculty, he did

[100] Board of State Hort. Commrs., *Rept.*, pp. 74–78, 110–112 (1883).
[101] *Pacific Rural Press*, vol. 26, p. 487 (Dec. 8, 1883).
[102] *Rept. College of Agr.*, Univ. Calif., 1884, pp. 77–80 (1884).
[103] *Entomology in the College of Agriculture*, Calif. Agr. Expt. Sta., Bul. 16 (1884).

not serve that institution again. During the past forty-two years he has devoted his attention to private matters.

Dyar, Harrison Gray [104] (Fig. 182). Born at 331 Fifth Avenue, New York City, February 14, 1866; died at Garfield Hospital, Washington, D. C., January 21, 1929. At the time of his death he was custodian of Lepidoptera, U. S. National Museum, Washington, D. C. He received the degree of B. S. in chemistry at the Massachusetts Institute of Technology in 1889, A. M. at Columbia University in 1894, and Ph. D. there in 1895. He was assistant in bacteriology, College of Physicians and Surgeons, Columbia, 1896–1897; custodian of Lepidoptera, U. S. National Museum, 1897 until his death; entomological assistant, Bureau of Entomology, 1904–1916; Captain, Sanitary Department, Organized Reserves, U. S. Army, 1924 to 1929.

FIG. 182.—Harrison Gray Dyar (1866–1929) was a leading entomologist of this country. He did a great deal of work on the life histories of caterpillars and described butterflies, moths, and mosquitoes, being the foremost authority on the Culicidæ. (Photograph taken in 1928 was furnished by Dr. Dyar.)

His earliest entomological interest was in Lepidoptera, and an important paper on the classification of Lepidopterous larvæ in 1894 and other papers which followed soon placed him as one of the leading authorities in America in this order and at the head of the list in the study of caterpillars of moths and butterflies.

In 1900 he published on the Lepidoptera of the Harriman Alaska Expedition [105] and on the life histories of some North American

[104] Howard, L. O., *Science*, vol. 69, pp. 151–152 (1929); *Jour. Econ. Entom.*, vol. 22, p. 437 (1929).

[105] *Proc. Wash. Acad. Sci.*, vol. 2, pp. 487–501 (1900).

moths [106] and in 1902 appeared a monumental work entitled A List of North American Lepidoptera and Key to the Literature of This Order of Insects. Many other important papers on Lepidoptera were published by him.

In 1902 he began the study of mosquito larvæ and contributed that part to the mosquitoes of North and Central America and the West Indies.[107] After the death of F. Knab he took up the study of the adults also and after 1915 he has devoted practically all of his time to this work until he became the foremost American authority on the Culicidæ. He collected extensively throughout North America and particularly in the northwestern states, California, and Canada.

He named and described hundreds of Lepidoptera and Culicidæ and also named some Simuliidæ and other flies with R. C. Shannon.[108]

In January, 1913, he began publishing Insecutor Inscitiæ Menstruus, a periodical devoted to systematic entomology. This publication was discontinued after volume 14 (1926).

Some of the more important works by Dyar, not cited above, are:

Lepidoptera

The number of molts of lepidopterous larvæ, Psyche, vol. 5, pp. 420–422 (1890).

A classification of lepidopterous larvæ, N. Y. Acad. Sci., Ann., vol. 8, no. 4, pp. 194–232 (1894).

Notes on the larval-cases of Lacosomidæ (Perophoridæ) and life-history of Lacosoma chiridota *Grt.*, Jour. N. Y. Entom. Soc., vol. 8, pp. 177–180 (1900).

A list of North American Lepidoptera, U. S. Nat. Mus., Bul. 52, 723 pp. (1902).

Revision of the North American species of Pronuba *and* Prodoxus, Jour. N. Y. Entom. Soc., vol. 11, pp. 102–104 (1903).

List of Lepidoptera taken at Williams, Arizona by Messrs. Schwarz and Barber, Proc. Entom. Soc. Wash., vol. 5, pp. 223–232 (1903).

Additions to the list of North American Lepidoptera, *ibid.*, vol. 6, pp. 62–65, 103–117 (1904).

Lepidoptera of the Kootenai District of British Columbia, Proc. U. S. Nat. Mus., vol. 27, pp. 779–938 (1904).

A revision of the Hesperiidæ of the United States, Jour. N. Y. Entom. Soc., vol. 13, pp. 111–141 (1905).

New North American Lepidoptera, Jour. N. Y. Entom. Soc., vol. 15, pp. 50–53, 105–110 (1907); *Proc. Entom. Soc. Wash.*, vol. 11, pp. 19–29, 161 (1909–1910).

[106] *Proc. U. S. National Mus.*, vol. 23, pp. 255–284 (1900).

[107] Howard, L. O., Dyar, H. G., and Knab, F., *Carnegie Inst. of Washington*, 4 vols. (1912).

[108] *The North American two-winged flies of the Family Simuliidæ*, Proc. U. S. Nat. Mus., vol. 69, Art. 10, pp. 1–54 (1927).

Descriptions of some new species and genera of Lepidoptera from Mexico, Proc. U. S. Nat. Mus., vol. 38, pp. 229–273 (1911), *P. C. Jour. Entom.*, vol. 4, pp. 746–748 (1912); *Proc. U. S. Nat. Mus.*, vol. 42, pp. 39–106 (1912); vol. 47, pp. 365–409 (1915); vol. 51, pp. 1–37 (1917); vol. 54, pp. 335–372 (1919).

Report on the Lepidoptera of the Smithsonian Biological Survey of the Panama Canal Zone, *ibid.*, vol. 47, pp. 139–350 (1915).

Diptera—Culicidæ

Illustrations of the larvæ of North American Mosquitoes, Jour. N. Y. Entom. Soc., vol. 9, pp. 177–182, 1 pl. (1901); vol. 10, pp. 194–201, 4 pls. (1902); vol. 11, pp. 23–27, 2 pls. (1903).

The larvæ of Culicidæ classified as independent organisms (with Knab, F.), Jour. N. Y. Entom. Soc., vol. 14, pp. 169–230 (1906).

On the classification of mosquitoes (with Knab, F.), Can. Entom., vol. 39, pp. 47–50 (1907).

The mosquitoes of North and Central America and the West Indies (with Howard, L. O., and Knab, F.), Carnegie Inst., Washington, 4 vols. (1912).

The mosquitoes of Canada, Royal Can. Inst., Trans., vol. 13, pp. 71–120 (1921).

The mosquitoes of the United States, Proc. U. S. Nat. Mus., vol. 62, pp. 1–199 (1922).

Two new mosquitoes from California (with Knab, F.), Insecutor Inscitiæ Menstruus, vol. 12, pp. 125–127 (1924).

Some of the important Western insects named by Dyar are:

Coast tent caterpillar, *Malocosoma pluvialis* (Dyar).
Larger corn stalk borer, *Diatræa zeacolella* Dyar (Arizona, New Mexico).
Southern California cypress moth, *Herculia phœzalis* Dyar.
Arizona navel orange worm, *Myelois venipars* Dyar (Arizona).
Pinipestis cambiicola Dyar (Montana, Colorado, Idaho, Oregon).
Cacœcia negundana Dyar (Utah, Colorado, Eastern States).
Culex anips Dyar.
White-banded mosquito, *Culex stigmatosoma* Dyar.
Aëdes intrudens Dyar.
punctodes Dyar.
leuconotips Dyar.
cyclocerculus Dyar.
aboriginis Dyar.
hexodontus Dyar.
æstivalis Dyar.
cataphylla Dyar.
ventrovittis Dyar.
communis altiusculus Dyar.
masamæ Dyar.
tahœnsis Dyar.
increpitus Dyar.
Field mosquito, *Aëdes campestris* Dyar and Knab.

Edwards, Henry [109] (Fig. 183). Born at Ross, Herefordshire, England, August 27, 1830; died in New York City, June 9, 1891.

Henry Edwards was a tragedian and entomologist, who was nationally rated in both professions. His early life was devoted to the study of law but he early became an actor by profession, making "his first appearance as Rudolf, in Byron's Wonder."

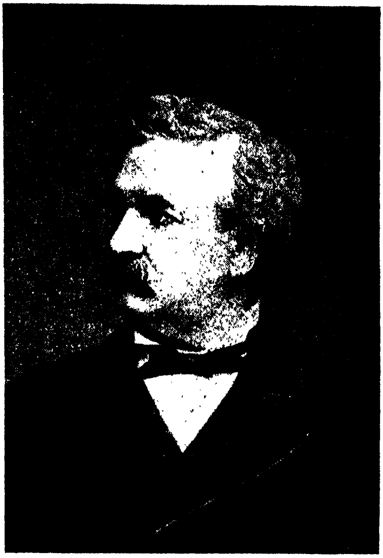

FIG. 183.—Henry Edwards (1830–1891) actor and lepidopterist, amassed a large collection of butterflies and moths and described many interesting species, especially in the family Ægeriidæ. (From Entom. News, 1891.)

In 1853 he traveled with a theatrical company to Australia, Peru, Panama, California, and Mexico, from whence he obtained the charming sketches for his book, A Mingled Yarn.[110]

He resided in California, with headquarters at San Francisco from 1865 to 1878, where he was associated with the famous old "California Theatre." In all the countries he visited he collected and otherwise obtained Lepidoptera, until at the time of his death he had one of the finest collections of butterflies in the United States. He also collected various insects, plants, and shells for others.

[109] Beutenmüller, W., Entom. Soc. Ontario, *22d Ann. Rept.*, pp. 96–97 (1891); *Can. Entom.*, vol. 23, pp. 141–142, 259–267 (1891).
Entom. News, vol. 2, pp. 129–130, portrait (1891).
Psyche, vol. 6, p. 118 (1891).
Zoe, vol. 2, pp. 391–392 (1891).
Insect Life, vol. 3, pp. 489–490 (1891).
Calif. Acad. Sci., *Proc.* (2), vol. 3, p. 367 (1890–1892).
Jesup, M. K., Am. Mus. Nat. Hist., *Ann. Rept.*, 1891, p. 12 (1892); *Ann. Rept.*, 1892, p. 10 (1893); *Ann. Rept.*, 1893, p. 12 (1894).
Smith, J. B., *Pop. Sci. Mthly.*, vol. 76, pp. 471–472, portrait (1910).
Wade, J. S., *Ann. Entom. Soc. Am.*, vol. 21, p. 498 (1928).
Vignettes of Henry Edwards and John Muir, Sci. Mthly., vol. 30, pp. 240–250 (March, 1930).

[110] *A Mingled Yarn* by Henry Edwards, Comedian (New York, Putnam's Sons, 1883), 157 pp. A copy in the library, University of California, Berkeley, contains a sketch of Edwards' Life which appeared in the *San Francisco Examiner*, June 10, 1891. It gives his birth as September 3, 1824, at Bristol, England.

In 1867 he was elected a member of the California Academy of Sciences; in 1874 he was a trustee; from 1875–1877 he was first vice-president, and on January 2, 1877, he became a life member. He was also a member and Grand Sire of the Bohemian Club where he was intimately associated with H. H. Behr. While in California he published an important series of papers entitled Descriptions of Pacific Coast Lepidoptera. [111]

He removed from California in 1877 and was at Boston in 1878 and went to New York in 1879, where he affiliated himself with the New York Entomological Society, and was one of the founders of and the editor of Papilio from 1881–1883. In 1881–1882 he published an important paper on the Ægeriidæ [112] in which were described a number of important California species. He again went to Australia in 1889 and returned to this country in 1890. At the time of his death he was president of the New York Entomological Society. His Bibliographical Catalogue of the Described Transformations of North American Lepidoptera appeared in U. S. National Museum, Bul. no. 35, 147 pp. (1889).

His collection, consisting of 250,000 specimens of Lepidoptera, one of the finest in existence at his death, and which includes many types, was bought by his friends for the benefit of his wife and presented to the American Museum of Natural History, New York, together with much of his correspondence and notes.

Some of the interesting and important Western Lepidoptera named by him are:

Elegant sphinx, *Sphinx perelegans* Hy. Edw.
Vancouver sphinx, *Sphinx vancouverensis* Hy. Edw.
Oak tussock moth, *Hemerocampa gulosa* Hy. Edw.
Pine halisidota, *Halisidota ingens* Hy. Edw.
Pacific poplar moth, *Ægeria pacifica* (Hy. Edw.).
Pacific peach tree borer, *Ægeria opalescens* Hy. Edw.
Strawberry crown borer, *Ægeria rutilans* (Hy. Edw.). Now a synonym of *Synanthedon bibionipennis* (Boisduval).
Wild cherry borer, *Ægeria græfi* (Hy. Edw.).
Douglas fir pitch moth, *Ægeria novaroënsis* Hy. Edw.
Cynipid gall moth, *Ægeria decipiens* Hy. Edw.
Red clearwing, *Ægeria polygoni* (Hy. Edw.).

[111] Calif. Acad. Sci., *Proc.*, nos. 1–22 (1877–1880); nos. 23–30, San Francisco, Calif.

[112] *New genera and species of* Ægeriidæ, Papilio, vol. 1, pp. 179–208 (1881); vol. 2, pp. 52–57 (1882).

Sequoia pitch moth, *Vespamima sequoiæ* (Hy. Edw.).
Man-root borer, *Melittia gloriosa* Hy. Edw.
Locust clearwing, *Paranthrene robiniæ* (Hy. Edw.).
The jumping oak gall, *Neuroterus saltatorius* (Hy. Edw.).

Ehrhorn, Edward Macfarlane (Figs. 174, 184). Born at San Francisco, California, January 24, 1862; at present retired from service of the Hawaiian Board of Agriculture and Forestry and now private consulting entomologist, residing at 2245 Oahu Avenue, Honolulu. He was educated in private schools in California and studied abroad in Hamburg, Germany, 1871–1878, and Grenchen, Switzerland, 1878–1879; at Brighton, England, 1879–1880; and at Stanford University, 1891, but received no higher degrees. Like many of the men of his day he acquired a knowledge of entomology by patient and diligent work and became one of the leading economic entomologists and horticultural quarantine officers in California. After he had a working knowledge of insects he began publishing systematic papers on Coccidæ of which he named a goodly number of California species. Later in 1890–1891 he was appointed assistant entomologist and deputy quarantine officer, State Board of Horticulture of California under Alexander Craw. From 1892–1904 he served as county entomologist and horticultural commissioner of Santa Clara County; in July, 1904, on the resignation of Craw, he was appointed horticultural quarantine officer and the deputy state commissioner of horticulture under Ellwood Cooper. He retained the latter position until 1909 when he again succeeded Craw as

FIG. 184.—Edward Macfarlane Ehrhorn (1862–   ) was the first official county entomologist in California. He described a number of Coccidæ and succeeded Alexander Craw as quarantine official first in California and later in Hawaii. (Photograph received in 1928. Also see Fig. 174.)

entomologist, Board of Agriculture and Forestry of Hawaii at Honolulu. He was also chief plant inspector until he retired in July, 1926.

From August 1, 1926, to August 1, 1927, he was consulting entomologist in termite control for the Bishop Trust Company and other institutions. Since that time he has devoted his time as a private consultant in termite control.

His more important papers are:

Report on grasshoppers and crickets in northern California, State Bd. Hort., Calif., Ann. Rept., 1891, pp. 192–193 (1892).

Report on horticultural conditions in various counties, *ibid.*, Ann. Rept., 1892, pp. 414–423 (1892).

New Coccidæ, Can. Entom., vol. 30, pp. 244–246 (1898).

Five new Coccidæ, *ibid.*, vol. 31, pp. 5–8 (1899).

Three new Coccidæ, *ibid.*, vol. 31, pp. 103–108 (1899).

New Coccidæ from California, *ibid.*, vol. 32, pp. 311–318, pl. 7 (1900); vol. 34, pp. 193–194 (1902).

A few new Coccidæ, with notes, *ibid.*, vol. 38, pp. 329–334 (1906); vol. 43, pp. 275–280, fig. 17 (1911).

A few notes on Coccidæ (Hawaiian), Proc. Hawaiian Entom. Soc., vol. 2, pp. 147–150, pl. 5 (1912).

Contributions to the knowledge of the Dactylopiinæ of Hawaii, *ibid.*, vol. 3, pp. 231–247 (1916).

Some of the important coccids named by Ehrhorn are:

Oak thread scale, *Xylococcus quercus* Ehrh.
Cottony greasewood scale, *Eriococcus adenostomæ* Ehrh.
Austin's kermes, *Kermes austini* Ehrh.
Cockerell's kermes, *Kermes cockerelli* Ehrh.
Cottony kermes, *Kermes shastensis* Ehrh.
Cottony cypress scale, *Ehrhornia cupressi* (Ehrh.).
Eriogonum mealybug, *Pseudococcus eriogoni* Ehrh.
The grape mealybug, *Pseudococcus maritimus* (Ehrh.).
Woolly oak scale, *Trionymus villosa* (Ehrh.).
Artemisia mealybug, *Phenacoccus artemisiæ* Ehrh.
Bunch grass scale, *Aclerda californica* Ehrh.
Cottony poison oak scale, *Pulvinaria rhois* Ehrh.

The following scale insects were named for Ehrhorn:

Cottony cypress scale, *Ehrhornia cupressi* (Ehrhorn).
Ehrhorn's oak scale, *Mycetococcus ehrhorni* (Ckll.).
Douglas fir scale, *Aspidiotus ehrhorni* Coleman.

The hymenopterous parasite, *Cirrhencyrtus ehrhorni* (Timberlake), also bears his name.

Eisen, Gustavus Augustus [113] (Fig. 185). Born at Stockholm, Sweden, August 2, 1847; at present residing at 146 East 49th Street, New York City. He was educated in Sweden and received the degree of Ph. D. from the University of Upsala in 1872, where he was also docent in zoölogy in the same year. He later studied spiders under T. Thorell. He came to the United States in October, 1872, and soon came to California where he first settled in Fresno. He was appointed state quarantine guardian at Fresno by the State Board of Horticultural Commissioners, April 23, 1886. He was naturalized in 1887. He became specially noted as a horticulturist or, to use his own words, as a "horticultural land and raisin expert with twenty years' experience in Europe, Mexico, Central America and California." [114]

FIG. 185.—Gustavus Augustus Eisen (1847–) first called attention to the necessity of introducing the blastophaga into California to caprify the Smyrna figs and assisted in the introduction of the first insects in 1891, though many trials were afterwards necessary to establish the species. (Photograph of a portrait painted by Wilford S. Conrow in 1924 and destined for the University of Upsala, Sweden, kindly furnished by Mr. Conrow.)

Raisins and figs, particularly the Smyrna fig and caprification, claimed most of his attention during the earlier years of his residence here. He first called attention to the necessity of introducing the blastophaga and caprifigs in order to produce Smyrna figs in California and was responsible for the introduction of the blastophaga in 1891. (See blastophaga.) During part of the time he

[113] Nelson, Edward W., *Nat. Acad. Sci., Mem.*, vol. 16, p. 145 (1922).

[114] *The raisin industry, etc.* (San Francisco, H. S. Crocker & Co., 1890). (An announcement appears in the back of the book.)

was engaged in this work he was employed by L. O. Howard, who was also very much interested in this particular problem. Eisen states that in his views of the caprification of the Smyrna figs by this insect, he was strongly opposed by many German and American entomologists, who declared the use of the blastophaga useless, mythical, and supercilious.[115] He early became affiliated with the California Academy of Sciences and was curator from 1892–1900 and a member of the Academy expeditions to Lower California in the years 1892, 1893, and 1894. As a result of these trips he "published two important papers on the geography and geology of southern Lower California, with the best maps of that region which have yet appeared." [116]

He was also the originator of the idea of creating the Sequoia National Park.[117]

In systematic work he was interested in the Oligochæta (marine worms) and the plasmocytes of human and batrachian blood, concerning which he published an account in the Memoirs and Proceedings of the California Academy.

In 1903 he became interested in archæological work and during the period from 1903–1915 he studied chiefly early Christian and Jewish archæology and antique glass in Spain, Italy, Algiers, Tunis, Morocco, and Egypt. From 1910–1915 also he studied in the principal museums of Europe.

In all he is the author of some 90 papers and books, chief of which are the following:

The fig, Fifth Ann. Conv., Calif. Fruit Growers, Los Angeles, pp. 42–50 (Caprification, pp. 48–50) (1885).

The fig, State Board Hort., Calif., Bien. Rept., 1885 and 1886, pp. 105–118 (1887).

The raisin industry, A practical treatise on the raisin grapes, their history, culture and curing (San Francisco, H. S. Crocker & Co., 1890), 223 pp., illustrs., plates. (*Insect pests*, pp. 98–103.)

The introduction of Blastophaga psenes *into California*, Zoe, vol. 2, pp. 114–115 (1891); *Insect Life*, vol. 4, pp. 128–129 (1891).

Report on the grasshopper plague in the upper Sacramento Valley in June, 1891, State Bd. Hort., Calif., Ann. Rept., 1891, p. 193 (1892).

On California Eudrilidæ (worms), Calif. Acad. Sci., Mem., vol. 2, no. 3, pp. 21–62, pls. xii–xxix (1894).

Pacific coast Oligochæta (worms), *ibid.*, Mem., vol. 2, nos. 4, 5, pp. 63–198,

[115] The great English entomologist, J. O. Westwood, had fully discussed this entire subject as early as 1840 (see references under blastophaga).

[116] Nelson, E. W., *op. cit.*, p. 145 (1922).

[117] *Who's Who in Am.*, vol. 14, p. 654 (1926–1927).

pls. xxx–lvii (1895–1896); Proc. (3), Zoöl., vol. 2, no. 2, pp. 85–276, pls. v–xiv (1900).

Biological studies on figs, caprifigs, and caprification, ibid., Proc. (2), vol. 5, pp. 897–1001 (1896).

Explorations in the Cape Region of Baja California, in 1894, with references to former expeditions of the Calif. Acad. of Sciences, ibid., Proc. (2), vol. 5, pp. 733–775, 5 maps (1895); Am. Geog. Soc., *Bul.*, vol. 29, no. 3, pp. 271–280, 1 map (1897).

Plasmocytes; the survival of the centrosomes and archoplasm of the nucleated erythrocytes, as free and independent elements in the blood of Batrachoseps attenuatus *Esch., ibid.*, Proc. (3), Zoöl., vol. 1, no. 1, 72 pp., 2 pls. (1897).

The fig: its history, culture and curing with a descriptive catalogue of the known varieties of figs, U. S. Dept. Agr., Div. Pom., Bul. 9, 317 pp., 16 pls. (1901).

Notes on plantations of caprifig trees, State Bd. Hort., Calif., Fruit Growers' 26th Conv., pp. 118–122 (1902).

The great chalice of Antioch (New York, Kouchakji Freres, 1924), 2 vols.

At least one insect, Eisen's mosquito, *Anopheles eisini* Coq., of Central America, bears his name.

Eschscholtz, Johann Friedrich [118] (Fig. 186). Eschscholtz was the outstanding entomological figure during the Russian occupation of California. He was born at Dorpat, Russia, November 1, 1793, and died at the same place on May 7,[119] 1831, at the age of thirty-eight years. He was well educated, having received a degree as Doctor of Medicine. At the time of his death he was Professor Extraordinary of Medicine and teacher at the University of Dorpat, Professor of Zoölogy and director of the zoölogical museum at the University of Dorpat, member of the natural history societies of Moscow and of the Leopold-Carolin Academy of Natural Research of Bonn, and Knight of the Order of Wladimir.

He acted as physician and naturalist on the ship *Rurik* which sailed around the world under the command of Otto von Kotzebue during the years 1815–1818.[120] On the same ship was a close friend, the German poet and naturalist, Adelbert von Chamisso,[121] to whom Eschscholtz turned over most of his captures on

[118] Rathke, M. H., *Zoöl. Atlas von Friedr. Eschscholtz*, vol. 5, pp. iii–viii (1833).

Asmuss, H., et al., *Collection of Coleoptera of Eschscholtz*, Bul. Moscow, vol. 7, pp. 81–97 (1834).

Hagen, H. A., *Biblio. Entom.*, vol. 1, pp. 214–215 (1862) (bibliography).

Marseul, S. A. de, *Les entomologistes et leurs écrits*, L'Abeille, vol. 21, pp. 73–75 (1883) (bibliography).

Horn, W., and Schenkling, S., *Index Litt. Entom.*, vol. 1, pp. 326–327 (1928).

[119] This is the date given by M. H. Rathke; H. A. Hagen gives May 19, 1831, as the date of his death.

[120] See account of same, p. 51.

[121] Chamisso, Adelbert von (Louis Charles Adelaide de) (Fig. 187). Born at the Château of Boncourt in Champagne, France, January 30, 1781; died in Berlin,

that voyage. The insects, however, he apparently retained. The ship arrived in San Francisco Bay, October 1, 1816, and remained until November 1. On this trip Eschscholtz did not visit the Russian colony at Ross and confined his collecting to the Presidio at San Francisco, the Mission, and the area between. Natural history specimens were scarce and it appears that little was taken in the way of insects. He did, however, take two very common California species of butterflies, the monarch or milkweed butterfly, *Danaus menippe* (Hübner), which he listed as *Idea plexippus* (Linn.), and the checker-spot or chalcedon, *Euphydryas chalcedona* (Dbld. & Hew.).[122] It was on this trip that the California poppy was collected, which Chamisso afterwards named *Eschscholtzia californica* because of his friendship for Eschscholtz. On this trip Eschscholtz had taken a considerable number of Coleoptera in August and September,

FIG. 186.—Johann Friedrich Eschscholtz (1793-1831) was the ablest of the early Russian entomologists, who described California insects. He visited the Pacific Coast and collected specimens there in 1816 and in 1824. He also took and described other animals as well as plants. (From the Zoöl. Atlas, 1829–1833.)

Germany, August 21, 1838. Poet and botanist. Leaving France at the time of the Revolution he settled in Berlin, where he became a page-in-waiting to the queen in 1796 and entered the Prussian army as ensign two years later. He began verse in 1803 which was interrupted by war in 1806. In 1810 he came under the spell of Madame de Staël, and, following her into exile at Coppet, Switzerland, devoted two years to the study of botany. Returning to Berlin in 1812 he continued his studies and in 1813 wrote his most famous work, the prose narrative, Peter Schlemihl (the man who sold his shadow). In 1815 he was appointed naturalist to the Otto von Kotzebue expedition around the world in the Russian ship *Rurik*. On this voyage he was associated with J. F. Eschscholtz, the ship's surgeon, and visited San Francisco Bay in October, 1816, where the California poppy was collected and named after his friend Eschscholtz in 1820. He later described many other plants taken on this voyage in co-authorship with Dietrich F. L. von Schlechtendahl (1794–1866), Professor at Halle. Upon his return to Berlin he was made custodian of the botanical gardens in Berlin. At the age of 48 he again returned to literature and made a much greater reputation as a poet than he had made as a scientist.

[122] According to Fordyce Grinnell, H. H. Behr saw the specimens taken by

1816, among the Aleutian Islands and particularly at Unalaska, prior to the visit to California. On the visit to the Sandwich Islands in November, 1916, he collected, on the Island of Oahu (Waahoo), the beautiful butterfly which he named *Vanessa tameamea.* On this trip he also made extensive collections chiefly in various orders in the Philippine Islands, Brazil, Chile, and other places. The results of this trip were largely published in the Entomographien in Berlin in 1822.[123] Some of the specimens taken on this first voyage were also turned over to Fischer von Waldheim and other Russian entomologists.

The second voyage with Kotzebue was made in the ship *Predprixtie* (*Enterprise*) during the years 1823–1826. Eschscholtz was chief naturalist and Hoffman, who acted as his assistant, apparently turned everything he collected over to him. Thus he amassed a large and important collection on this trip particularly in the tropics, at Unalaska and Sitka, and in California. They arrived in San Francisco Bay on September 27, 1824, and remained until November 25. During the stay in California, collections were made around San Francisco Bay, Santa Clara, San Rafæl, Ross, Bodega Bay, and the lower portions of the Sacramento River, possibly to the present site of Rio Vista. He remained a week at Ross where a large series of Coleoptera was taken. In addition to insects he collected other animals and plants as well. Among the interesting animals, apart from insects, collected and afterwards described are: the California valley coyote, *Canis ochropus* Esch.; the large marbled salamander, *Dicamptodon ensatus* (Esch.) (*Triton*); the slender salamander, *Batrachoseps attenuatus* (Esch.) (*Salamandrina attenuata* Esch.).[124] He also described the common sand dollar, *Dendraster excentricus* (Esch.) (*Scutella excentricus* Esch.), which occurs along the Pacific Coast from San Pedro, California, to Unalaska. His specimens were from Unalaska.

Eschscholtz in the collections of the Berlin Museum, *Bul. Brook. Entom. Soc.*, vol. 9, p. 68 (1914). They must have been placed there by Chamisso, whose collection is there.

[123] *Entomographien*, Erste Lieferung (Berlin, Reimer, 1822), vol. 8, p. 9, mit. 2 illum. Tafeln., 128 u.pg.3. Register (Coleoptera, Orthoptera, Hymenoptera, Hemiptera).

[124] *Zoölogischer Atlas*, vol. V, pp. 1–16 (1833). Eschscholtz also collected the Pacific Coast Newt, *Triturus torosus* (Rathke), described after his death by M. H. Rathke.

Storer, Tracy I., *A synopsis of the Amphibia of California*, Univ. Calif. Pub. Zoöl., vol. 27, pp. 48, 79–80 (1925).

FIG. 187.—Adelbert von Chamisso (Louis Charles Adelaide de Chamisso) (1781–1838), poet and botanist, accompanied Lieut. Otto von Kotzebue and Eschscholtz to the Pacific Coast in 1816. The California poppy was collected in October of that year at the Presidio San Francisco and later named *Eschscholtzia californica* by Chamisso in 1820. (After Ludwig Geiger, 1907.)

In addition to his zoölogical contributions, Eschscholtz is also to be remembered for his botanical work in California. The seventy-eight species of plants taken on the first Kotzebue voyage, although partly collected by Eschscholtz, in the area of the Presidio, the Mission, and the district between, were turned over to the naturalist in charge, Adelbert von Chamisso, who either described them alone, as in the case of the California poppy, *Eschscholtzia californica* Cham., or in coauthorship with Diedrich F. L. von Schlechtendahl, as in the case of the California wild blackberry, *Rubus vitifolius* C. & S. The plants taken on the second voyage, however, were at least, in part, described by Eschscholtz. These species are common and often conspicuous throughout the Pacific Coast region. Among these may be mentioned the following: [125]

Yellow sand verbena, *Abronia latifolia* Esch. *Mém. de l'Acad., Imp. des Sci.*, St. Petersburg, vol. 10, p. 281 (1826).

Coffee berry, *Rhamnus californica* Esch., *ibid.*, p. 285.

California lilac, blue myrtle, or blue blossom, *Ceanothus thyrsiflorus* Esch., *ibid.*, p. 285.

Chamisso's lupine, *Lupinus chamissonis* Esch., *ibid.*, p. 288.

Blue witch nightshade, *Solanum umbelliferum* Esch., *ibid.*, p. 283.

Coast honeysuckle, *Lonicera ledebourii* Esch., *ibid.*, p. 284 (Jepson lists this as *L. involucrata* Banks var. *ledebourii* Jepson n. comb.).

In addition to the California poppy, the buttercup, *Ranunculus eschscholtzi* Schlechtendal, bears his name.

[125] In securing this information I am indebted to both Willis Lynn Jepson and Alice M. Eastwood.

Of the insects taken in California it is stated that there were nearly one hundred kinds of Coleoptera, all of which were new, excepting possibly one species believed to be *Lampyris corrusca* Fabr. which "according to Banks is found on the Columbia river." [126]

Among the common important beetles collected and described by Eschscholtz may be mentioned the following:[127]

California black tiger beetle, *Omus californicus* Esch. This species is recorded as having been collected near Point Reyes in November.[128]

* *Amara californica* Dej.

Calosoma cancellatum Esch. (Taken at San Francisco.)

* *Holciophorus ater* (Dej.) (*Pterostichus*).

* *Scaphinotus ventricosus* (Dej.).

* *Pterostichus californicus* (Dej.).

* Rufous carabid, *Calathus ruficollis* (Dej.).

Potato wireworm, *Dolopius lateralis* Esch.

The western twelve-spotted cucumber beetle, *Diabrotica soror* Leconte, was taken by Eschscholtz, but was wrongly identified by Russian entomologists as *D. duodecempunctata* (Fabr.).

Red-legged ground beetle, *Eulabis rufipes* Esch. (taken at Mission S. F.).

Cordate darkling ground beetle, *Eleodes cordata* Esch.

Dentate eleodes, *Eleodes dentipes* Esch.

Margined eleodes, *Eleodes marginata* Esch.

Quadrate eleodes, *Eleodes quadricollis* Esch.

Ciliate sand beetle, *Cœlus ciliatus* Esch.

Coniontis viatica Esch.

Dermestes talpinus Mann. (collected by Eschscholtz).

Black spruce borer, *Asemum atrum* Esch.

The linear earwig, *Doru lineare* (Esch.).

Before his early death Eschscholtz visited the great French coleopterist, Dejean, at which time he drew up the scientific names and descriptions of many of the species he had collected on his voyages to America. After the death of Eschscholtz, Dejean published most of them under the name of Eschscholtz, but the rules of nomenclature have since credited all of these species to Dejean

* These and many other species were collected by Eschscholtz and described in manuscript. These descriptions were later published by Dejean and are therefore credited to him.

[126] Kotzebue, Otto von, *A new voyage round the world in 1823–26* (2 vols. translated, London, 1830), vol. II, p. 356.

[127] *Zoölogischer Atlas* (Berlin, Reimer, 1829–1833), vols. i-v.

[128] Eschscholtz was at Point Reyes on October 10 or 11, 1824, when the flotilla of small boats, which was conveying him from Ross to San Francisco Bay, was forced ashore by a storm, and this beetle was probably collected then.

and that is why the name of the French Count figures so prominently in the entomological names of California and Alaska.

Carl Gustav Mannerheim also listed, described, and named some ninety-two species collected by Eschscholtz in Alaska and California. (See Mannerheim, p. 699.)

Eschscholtz was an authority on the Buprestidæ and the first great student of the Elateridæ and the monumental work on this family begun by him was finished by his friend and associate, Ernest F. Germar.

Eschscholtz was a general zoölogist as well as an entomologist, but his chief interests were centered in insects. This may be emphasized by the fact that on his last voyage he collected in all 2,400 kinds of animals, of which 1,400 were insects.[129]

The insects taken on his first trip around the world are in the Museum of the University of Dorpat and his general collections are among those of the Society of Natural History in the Imperial Museum of Moscow.

Eschscholtz wrote the following papers which refer to plants and animals collected on the Pacific Coast of North America:

Entomographien, Erste Lieferung (Berlin, Reimer, 1822), 8 mit., 2 illum. Tafeln., 128 pp. (Coleoptera, Orthoptera, Hymenoptera, Hemiptera, taken on first Kotzebue voyage.)

Zoölogischer Atlas, enhaltend Abbildungen neuer Thierarten wahrend des Flottcapitains von Kotzebue zweiter Reise um die Welt, auf der Russich-Kaiserlichen Kriegeschlupp Predpriætie in den Jaren 1823–1826 (Berlin, Reimer), mit. illum. Tafeln XXIV, Heft I, pp. I–IV+1–17; II, pp. 1–13; III, pp. 1–18 (1829); IV, pp. 1–19 (1831); V, pp. 1–28 (1833). (These papers contain descriptions of insects with 4 colored plates, salamanders, mammals, molluscs, cœlenterates, birds, and reptiles, taken on the second Kotzebue voyage. The last part (V) was published by M. A. Rathke after the death of Eschscholtz and contains a short biographical sketch of his life.)

Descriptiones plantarum novæ Californiæ, adjectis florum exoticorum analysibus, Mémoires de l'Acad. de St. Petersb., T. X., pp. 281–292 (1826).

Fabricius (Schmitt), Johann Christian[130] (Fig. 188). Born at Tondern, Schleswig, Denmark, January 7, 1745; died at Kiel,

[129] Kotzebue, Otto von, *A new voyage, etc., op. cit.*, vol. II, pp. 361–362 (1830).

[130] Latreille, P. A., *Ann. du Mus. d'Hist. Nat.*, vol. 11, pp. 393–404 (1808).

Kieler Blätt, vol. 1, pp. 88–117 (1819).

Hope, F. W., *Translation of Autobiography*, Trans. Entom. Soc. London, vol. 4, pp. i–xvi, portrait (1845).

Hagen, H. A., *Bibliot. Entom.*, vol. 1, pp. 220–222 (1862).

Marseul, S. A. de, *L'Abeille*, vol. 26, pp. 269–272 (1889).

Berlese, A., *Gliinsetti* (Milano, Kramer, 1909), vol. 1, p. 25.

March 3, 1808. Being the son of a Danish physician he was well educated at the Universities of Copenhagen and Upsala, and a student of Linnæus for two years at the latter. Although a professor of political economy at the Universities of Copenhagen and Kiel from which he made his living, his great love was for the study of insects, which afterwards placed him as a contemporary with his great teacher in this subject. He was primarily a systematist and originated the maxillary or cibarian system of classification of insects in which the mouth parts were used to separate the orders. This system recognized thirteen orders of which only one, the Odonata, survives today. He was an extensive traveler and visited most of the great entomologists in Europe during his lifetime. In this way he gained access to specimens from all over the world, and, next to Linnæus, described more of the common outstanding insects in Europe than anyone else. He also named a large number from North America and other parts of the world.

FIG. 188.—Johann Christian Fabricius (1745–1808), the great Danish entomologist, the worthy successor to Linnæus, and the originator of the maxillary system of classifying insects. He named a very great many of our common important economic insects. (After F. W. Hope, 1845.)

His large personal collection is at the University of Kiel, while series of types described by him are in the Joseph Banks collection in the British Museum and in the museums at Copenhagen and Oxford.

His most important papers are:

Systema Entomologica sistens insectorum classes, ordines, genera, species, etc. Flensburgi et Lipsiæ, Korte (1775).

Genera insectorum eorumque characteres naturales, etc., Chilonii, Bartsch (1782).

Dow, R. P., *Bul. Brooklyn Entom. Soc.*, vol. 8, p. 38 (1913).

Schuster, J., *Linné u. Fabricius* (München, Verlag Münchener Drucke), 26 u, 117 u, 21 pp., portrait (1928).

Horn, W., and Schenkling, S., *Index Litt. Entom.*, vol. 1, pp. 334–336 (1928); vol. 4, p. 1395 (1929).

Mantissa Insectorum sistens, etc., Hafniæ, Proft. (1787).
Entomologica Systematica, emendata, etc., vols. I–IV (1792–1794).
Systema Eleutheratorum, secundum ordines, genera, etc., Kiliæ, vol. 2 (1801).
Rhyngotorum, C. Reichard, Brunsvigæ, 314 pp. (1803).
Piezatorum, Reichard, Brunsvigæ, vol. 14, 439 pp. (1804).

By comparing the two lists of common insects described and named by Fabricius and Linnæus, it will be seen that the former was not far behind his illustrious teacher, but it is evident that the first in the field had a great advantage over all his followers.

Black widow spider, *Latrodectus mactans* Fabr.
Silver orb spinner, *Argiope argentata* (Fabr.).
Black earwig, *Chelisoches morio* (Fabr.).
Field cricket, *Gryllus assimilis* (Fabr.).
* Australian cockroach, *Periplaneta australasiæ* (Fabr.).
* Giant bird louse, *Ancistrona vagelli* (Fabr.).
Ruby spot, *Hetærina americana* (Fabr.).
Giant lacewing, *Polystæchotes punctatus* (Fabr.).
Buffalo treehopper, *Ceresa bubalus* (Fabr.).
Green clover hopper, *Stictocephala inermis* (Fabr.).
Oak treehopper, *Platycotis vittata* (Fabr.).
Red-shouldered plant bug, *Thyanta custator* (Fabr.).
Anchorage bug, *Stiretrus anchorago* (Fabr.).
Spined soldier bug, *Sinea diadema* (Fabr.).
Bee assassin, *Apiomerus crassipes* (Fabr.).
Green calosoma, *Calosoma scrutator* Fabr.[131]
Murky ground beetle, *Harpalus caliginosus* (Fabr.).
* Hide and tallow dermestid, *Dermestes vulpinus* Fabr.
Green tragositid, *Temnochila virescens* (Fabr.).
* Squash ladybird, *Epilachna borealis* (Fabr.).
* Broad-horned flour beetle, *Gnathocerus cornutus* (Fabr.).[132]
* Red flour beetle, *Tribolium ferrugineum* (Fabr.).
* Cigarette beetle, *Lasioderma serricorne* (Fabr.).
Wasp-like clerid, *Enoclerus sphegeus* (Fabr.).
* Strawberry rootworm, *Paria canella* (Fabr.).
* Tobacco flea beetle, *Epitrix parvula* (Fabr.).
Cottonwood leaf beetle, *Lina scripta* (Fabr.).
* Four-spotted bean weevil, *Mylabris quadrimaculatus* (Fabr.).
Rose snout beetle, *Rhynchites bicolor* (Fabr.).
* Black vine weevil, *Brachyrhinus sulcatus* (Fabr.).

* Introduced into California.

[131] Fabricius named the first insect taken on the Pacific Coast. It was a beetle, *Carabus tædatus* Fabr., which is supposed to have been collected by a member of James Cook's third voyage at Unalaska and described at the British Museum and the description published in 1806.

[132] The first specimen of this species taken in California was found in an army biscuit by Geo. H. Horn.

* Clover leaf weevil, *Hypera punctata* (Fabr.).
* Lesser clover leaf weevil, *Phytonomus nigrirostris* (Fabr.).
* Bulb fly, *Merodon equestris* (Fabr.).
Red-tailed tachina fly, *Winthemia quadripustulata* (Fabr.).
* Cluster fly, *Pollenia rudis* (Fabr.).
* Screw worm, *Cochliomyia macellaria* (Fabr.).
White-lined sphinx, *Celerio lineata* (Fabr.).
Virginia tiger moth, *Diacrisia virginica* (Fabr.).
* Corn earworm, *Heliothis obsoleta* (Fabr.).
Horntail, *Urocerus albicornis* (Fabr.).
Fire ant, *Solenopsis geminata* (Fabr.).
Western red ant, *Formica rufibarbis* Fabr. var. *occidua* Wheeler.
Maculate carpenter ant, *Camponotus maculatus* (Fabr.).
Yellow bumblebee, *Bremus fervidus* (Fabr.).

Fall, Henry Clinton (Fig. 189). Born at Farmington, New Hampshire, December 25, 1862; at present retired from a life of educational work in science and mathematics, and living at Tyngsboro, Massachusetts. He graduated from Dartmouth College with the degree of B. S. in 1884 and devoted his life to educational work for many years in connection with the Pasadena High School. In June, 1929, he received the honorary degree of Doctor of Science from his Alma Mater.

He has collected in most parts of the United States and Canada, but more particularly in New England, Florida, California, and Alaska. The many years he resided in southern California enabled him to become the foremost authority on the Coleoptera of that region.

He is one of the leading workers on Coleoptera in California and has described more new species from this state than any of the present living coleopterists, having named over 1,200 species and varieties. His collection of North American (United States and Canada) Coleoptera is one of the finest, if not the greatest private collection in America. It consists of 13,500 species, 100,000 mounted specimens, including more than 1,000 types, and many paratypes of other authors.

He has published nearly one hundred papers in the various entomological periodicals.[133]

Among his most important papers are:

Revision of the species of Apion *of America, North of Mexico,* Trans. Am. Entom. Soc., vol. 25, pp. 105–183, pls. ii–v (1898–1899).

* Introduced into California.

[133] His first paper, *California notes,* appeared in vol. 4, p. 235 (1893).

Synopsis of the species of Acmæodera *of America, North of Mexico*, Jour. N. Y. Entom. Soc., vol. 7, pp. 1–37 (1899).

Revision of the Lathridiidæ of Boreal America, Trans. Am. Entom. Soc., vol. 26, pp. 101–190, pls. iii–v (1899).

FIG. 189.—Two famous American entomologists, Willis Stanley Blatchley (1859–) and Henry Clinton Fall (1862–), from a photograph taken on a collecting trip at Royal Palm Park, Florida, in April, 1925. (Photograph furnished by Dr. Fall.)

List of the Coleoptera of southern California, with notes on habits and distribution of new species, Calif. Acad. Sci., Occas. papers, vol. VIII, 282 pp. (1901).

Revision of the Ptinidæ of Boreal America, Trans. Am. Entom. Soc., vol. 31, pp. 97–296, pl. vii (1905).

The Coleoptera of New Mexico (with T. D. A. Cockerell), *ibid.*, vol. 33, pp. 145–272 (1907).

Revision of the species of Diplotaxis *of the United States*, *ibid.*, vol. 35, pp. 1–96, pl. i (1909).

Miscellaneous notes and descriptions of North American Coleoptera, *ibid.*, vol. 36, pp. 89–197 (1910).

A revision of the North American species of Pachybrachys, *ibid.*, vol. 41, pp. 291–486 (1915).

The North American species of Gyrinus, *ibid.*, vol. 47, pp. 269–306, pl. xvi (1922). (Also published separately by author.)

A review of the North American species of Agabus (Mount Vernon, N. Y., John D. Sherman, Jr., 1922), 36 pp.

A revision of the North American species of Hydroporus *and* Agaporus, 129 pp. (1923).

Fall has described a great many beetles from all parts of the country, as will be seen by consulting the above literature.

Felt, Ephraim Porter (Fig. 190). Born at Salem, Massachusetts, January 7, 1868; at present Chief Entomologist, Bartlett Research Laboratories, Stamford, Connecticut, since April 1, 1928, and editor of the Journal of Economic Entomology since its beginning in 1908. The greatest American authority on the gall midges or Cecidomyiidæ. Felt received the degree of B. S. at Massachusetts Agricultural College and also at Boston University in 1891 and Sc. D. from Cornell University in 1894. He was a teacher of natural science in Clinton Liberal Institute, Fort Plain, New York, 1893–1895; assistant to the state entomologist of New York, 1895–1898; state entomologist, 1898 to March 31, 1928; chief entomologist New York State Conservation Commission, 1923–1924; collaborator of the Bureau of

Fig. 190.—Ephraim Porter Felt (1868–), the greatest American authority of the gall midges, was state entomologist of New York from 1898 to 1928 and editor of the Journal of Economic Entomology since its beginning in 1908. (From a photograph taken March 26, 1928, by E. J. Stein and furnished by Dr. Felt.)

Entomology; entomological editor of the Country Gentleman, 1898–1911; member supervisory board, American Year Book; and the recipient of a gold and three silver medals at the Pan-American Exposition, Buffalo, N. Y., in 1901. He has long been one of the foremost entomologists of the eastern states and his extensive work on the Cecidomyiidæ, his editorial work on the Journal of Economic Entomology, and his published works on forest and shade tree insects have made his name familiar to all workers in this country and abroad.

His most important works are:

The mosquitoes or Culicidæ of New York State, N. Y. State Mus., Bul. 79 (Entom. 22), pp. 241–400, 113 figs., 57 pls. (1904).

Insects affecting park and woodland trees, ibid., Mem. 8, vol. 1, pp. 1–332, pls. 1–48 (1905); vol. 2, pp. 333–877, pls. 49–70 (1906).

Hosts and galls of Am. gall midges, Jour. Econ. Entom., vol. 4, pp. 451–484 (1911).

Key to American insect galls, N. Y. State Mus., Bul. 200, 309 pp., 250 figs., 16 pls. (1917).

A study of gall midges, N. Y. State Mus., I, Bul. 165, 28th Rept. State Entom., pp. 127–227, 64 figs., 4 pls. (1913); II, Bul. 175, 29th Rept., pp. 79–214, 23 figs., 14 pls. (1913); III, Bul. 180, 30th Rept., pp. 127–289, 101 figs., 16 pls. (1915); IV, 31st Rept., pp. 101–173, 39 figs., 6 pls. (1916); V, 32d Rept., pp. 101–253, 53 figs., 6 pls. (1918); VI, 33d Rept., pp. 76–196, 73 figs., 9 pls. (1918); VII, 34th Rept., pp. 81–241, 54 figs., 13 pls. (1921).

Key to gall midges (A résumé of studies I–VII, Itonididæ), ibid., no. 257, pp. 3–239, 57 figs., 8 pls. (February, 1925).

New western gall midges, Jour. N. Y. Entom. Soc., vol. 24, pp. 175–196 (1916).

Manual of Tree and Shrub Insects (New York, Macmillan Co., 1924), 382 pp., 256 figs.

His splendid collection of Cecidomyiidæ and other insects is in the New York State Museum, Albany, N. Y.

Felt named a great many Western gall midges, some of which are:

Wild rye midge, *Rhabdophaga elymi* Felt.
Rhabdophaga racemi Felt.
Dasyneura lupini Felt.
Artemisia gall midge, *Diarthronomyia artemisiæ* Felt.
Diarthronomyia californica Felt.
flocculosa Felt.
occidentalis Felt.
Alfalfa gall midge, *Asphondylia websteri* Felt.
Cactus fruit gall fly, *Asphondylia opuntiæ* Felt.
Mycodiplosis acarivora Felt.

Arthrocnodax occidentalis Felt.
Aphidoletes meridionalis Felt.
Coccidomyia erii Felt.
Itonida hopkinsi Felt.
California currant midge, *Phytophaga californica* Felt.
Baccharis gall midges, *Rhopalomyia baccharis* Felt and *R. californica* Felt.
Wild sage gall fly, *Rhopalomyia salviæ* Felt.

Field, George Hamilton [134] (Fig. 191). Born in Boston, Mass., October 4, 1850; at present residing at 1859 Julian Avenue, San Diego, California. An old-time entomological collector in southern California. He graduated from the high school at Winchester, Mass., in June, 1868, and then took a short course at the Commercial College in Boston. He left Boston in May, 1869, and settled along the old Fremont Trail two miles west of Lawrence, Kansas, where he was a cowboy on the cattle trail between Texas and Kansas. In 1875 he went to Philadelphia and studied in the office of a physician until the spring of 1876, when he returned to Kansas and brought his mother to Napa Valley, California, for her health. Having received some land from his father, he returned with his mother to Coffey County, Kansas, in 1877 where he farmed until 1889, when he removed to San Diego, California, with his family. For twenty-six years and until 1919 he was head janitor of the city schools of San Diego.

Fig. 191.—George Hamilton Field (1850–), an amateur collector of insects, especially butterflies and moths, in southern California. (Photograph taken in 1928.)

He became interested in natural history in 1895 when he became acquainted with George W. Dunn, who at that time was collecting Coleoptera in California. Field began a collection of beetles at once, but he was later compelled to give up his entomological work.

[134] Fall, H. C., *Entom. News*, vol. 19, pp. 159–161 (1908).
Gunder, J. D., *Entom. News*, vol. 40, p. 34 (1929).

Later on, with his boys he again took up the collecting of insects—this time butterflies and moths—and his vacations and spare time were assiduously devoted to this work. Besides making a collection of his own he collected moths for Frank A. Merrick, Wm. Barnes, J. McDunnough, H. G. Dyar, J. B. Smith, J. A. Grossbeck, W. G. Wright and others.

He published but one paper and that on larvæ of *Datana robusta* Strecker.[135]

He also again took up the collecting of Coleoptera and furnished a great deal of material to H. C. Fall,[136] E. C. Van Dyke, A. Fenyes, F. E. Blaisdell, and others. He took a large series of the rare scarabæid, *Dinacoma marginata* Casey, at Ocean Beach, California, and sold two to Blaisdell at $1.50 each, which was about all he ever made out of his collecting. He also rediscovered the carabid, *Platynus agilis* Lec., in 1924.

Most of his collecting was done in the southwest in the more remote places in San Diego and Imperial counties, California, and in Lower California.

He was identified with the San Diego Society of Natural History—secretary for several years and curator of insects, 1920–1922. He has done little entomological work since 1924.

His collection of butterflies and moths number from 700 to 800 species.

Fischer, F. Practicing physician in the Russian American Company. He collected chiefly in the Aleutian Islands, Alaska, but was at Ross during the later years of the Russian occupation, probably sometime between 1835–1840. The most important species collected by him are:

Calathus behrensi Mann.
Harpalus albionicus Mann.
Eleodes fischeri Mann., synonym of *E. marginata* Esch. (Also taken by Eschscholtz.)
Eleodes reflexicollis Mann.
intricata Mann.
Coniontis eschscholtzi Mann. (Also collected by Tschernikh.)

As shown above, all of the beetles taken by Fischer were described by Mannerheim.[137]

[135] *Notes on the larvæ of* Datana robusta *Strecker*, Jour. N. Y. Entom. Soc., vol. 15, pp. 54–56 (1907).

[136] Fall named the scarabæid beetle, *Thyce fieldi*, for him.

[137] *Descriptiones de deux Coléoptères nouveaux de la Californie.* Revue Zoölogique

Kashevaroff writes that Fischer was a member of the medical staff on the eleventh voyage of the Russians around the world on the ship *Nicholas I* in command of Berends. He was also a botanist and wrote a paper on the Plantes recueillies pendant le voyage des Russes autour du monde, v, Langsdorff, G. H., 1810.

Fischer von Waldheim, Gotthelf[138] (Fig. 192). Born at Waldheim, a small village between Freyberg and Leipzig in Saxony, Germany, October 3 (Hagen and Horn give October 15), 1771; died in Moscow, October 18, 1853. (Also given October 13, 1853.) He graduated with a doctor's degree from the College of Freyberg at the age of twenty-six and then went to the University of Leipzig. He was one of the leading naturalists of his time, becoming Professor of Natural History at Mayence in 1798. He afterwards went to Russia where he founded the Imperial Society of Naturalists of Moscow in 1805 and where he was president of the Academy of Natural History of Moscow and the leading entomologist of Russia at that time. He is of special interest to entomologists of the West because he described many of the Coleoptera collected by Eschscholtz on his first voyage to Alaska and California in 1816. In all he published 50 papers chiefly on Coleoptera and Orthoptera, but he also worked somewhat in Hymenoptera. His most important paper to Americans is his Entomographia imperii russici; Genera

FIG. 192.—Gotthelf Fischer von Waldheim (1771–1853) was the leading Russian entomologist of his time at Moscow during the early Russian occupation in North America and described many of the insects collected in Alaska and California. (From Entomographie de la Russie, 1920.)

par la Société Cuvierienne, S. 137 (1840); Beitrag zur Käfer-Fauna, etc., *op. cit.* (1843).

[138] Amyot, C. J. B., *Ann. Soc. Entom. France* (3), vol. 3, pp. 323–325 (1855).
Motschulsky, T. V., *Etudes Entom.*, vol. 4, pp. 1–7 (1855).
Hagen, H. A., *Bibliot. Entom.*, vol. 1, pp. 234–237 (1862).
Marseul, S. A., de, *L'Abeille*, vol. 21, pp. 117–120 (1883).
Wade, J. S., *Ann. Entom. Soc. Am.*, vol. 21, p. 499 (1928).
Horn, W., and Schenkling, S., *Index Litt. Entom.*, vol. 2, pp. 357–359 (1928), vol. 4, p. 1396 (1929).

Insectorum systematice exposita et analysi iconographica instructa, etc. T. 5, 1820–1851, Moscow (also listed as Entomographie de la Russie), which contains the descriptions of Siberian, Alaskan, and Californian beetles, chiefly Carabidæ. Portions of his collections are in the Zoölogical Museum of the Imperial Academy at Moscow and the remainder in private collections.

FIG. 193.—Asa Fitch (1809–1879), the first American entomologist commissioned by a state. He was the author of a series of splendid state reports on insects and also did some important taxonomic work, especially in the orders Homoptera and Hymenoptera. (Photograph furnished by Dr. E. P. Felt.)

Some of the interesting western beetles named by Fischer are:

Carabus chamissonis Fischer. Alaska.

Carabus baccivorus Fischer, a synonym of *C. tædatus* Fabr. (The first insect taken from the Pacific Coast of North America.)

Scaphinotus angusticollis (Fischer). Siberia, Alaska-No. California.

Scaphinotus marginatus (Fisher). Alaska-Oregon.

Fitch, Asa [139] (Fig. 193). Born at Salem, New York, February 24, 1809; died at same place, April 7, 1879. First American entomologist commissioned by a state and contemporary with Harris and Walsh. He was educated as a physician and practiced medicine for eight years, giving it up in 1838. His entomological studies began in 1840 and in 1845

[139] Hagen, H. A., *Bibliot. Entom.*, vol. 1, pp. 238–239 (1862).
Strecker, H., *Butterflies and moths of N. Am.*, pp. 228–229 (1878).
Thurston, E. P., *Pop. Sci. Mthly.*, vol. 16, pp. 116–120, portrait (1879).
Lintner, J. A., *Psyche*, vol. 2, pp. 273–276 (1879).
Riley, C. V., *Am. Entom.*, vol. 3, pp. 121–123 (1880).
Can. Entom., vol. 12, pp. 66–67 (1880).
Goding, F. W., Trans. N. Y. State Agr. Soc., *50th Ann. Rept.*, 1890, pp. 358–361 (1891).
Howard, L. O., *Insect Life*, vol. 7, pp. 60–63 (1894); U. S. Dept. Agr., *Yearbook*, 1899, p. 138, portrait (1900).
Entom. News, vol. 7, p. 65, portrait (1896).
Nat. Cyclop., Am. Biog., vol. 7, p. 252 (1897).
Fitch-Andrews, A. M., *N. Y. Gen. & Biog. Record*, vol. 34, pp. 155–158, portrait (1903).

he started publishing works on insects. In 1854 he was appointed by the New York State Agricultural Society, under authorization of the state legislature, as state entomologist and received an appropriation of one thousand dollars for the conduct of the work. In 1855 he issued the first of his fourteen reports, all of which were published in the Transactions of the New York State Agr. Society.[140] In addition to the reports he also published 103 other papers and addresses during his term of seventeen years as State Entomologist. His works were standard for the time and for many years afterwards and he is ranked as one of the great entomologists of this country. His systematic work was almost as extensive as his economic and he described a large number of the most important insect pests and parasites in America, among which are the following:

Wheat thrips, *Frankliniella tritici* (Fitch).
Bog leafhopper, *Helochara communis* Fitch.
Grass sharpshooter, *Dræculacephala noveboracensis* (Fitch).
Grape phylloxera, *Phylloxera vitifoliæ* Fitch.
Eastern chermes, *Chermes pinicorticis* Fitch.
Small alder aphis, *Myzocallis alnifoliæ* (Fitch).
Elder aphis, *Anuraphis sambucifoliæ* (Fitch).
Chokecherry aphis, *Aphis cerasifoliæ* Fitch.
Dogwood aphis, *Aphis cornifoliæ* Fitch.
Corn aphis, *Aphis maidis* Fitch.
Apple-grain aphis, *Rhopalosiphum prunifoliæ* (Fitch).
Cone flower aphis, *Macrosiphum rudbeckiæ* (Fitch).
Elm and grass aphis, *Colopha ulmicola* (Fitch).
Poplar stem gall aphis, *Pemphigus populicaulis* Fitch.
Oak lecanium, *Lecanium quercitronis* Fitch.
Pine leaf scale, *Chionaspis pinifoliæ* (Fitch).
Walnut tingid, *Corythucha juglandis* (Fitch).
Wheat stem maggot, *Meromyza americana* Fitch.
Berry plume moth, *Pterophorus tenuidactylus* (Fitch).
Willow aphis parasite, *Diæretus salicaphis* (Fitch).
Secondary parasite, *Dibrachys clisiocampæ* (Fitch).
Lecanium parasite, *Coccophagus lecanii* (Fitch).

Hopkins, A. D., et al., *Re Fitch's collection*, Proc. Entom. Soc. Wash., vol. 6, pp. 58–59 (1903).
Smith, J. B., *Pop. Sci. Mthly.*, vol. 76, p. 475, portrait (1910).
Comstock, J. H., *Jour. Econ. Entom.*, vol. 15, p. 33 (1922).
Wade, J. S., *Ann. Entom. Soc. Am.*, vol. 21, p. 499 (1928).
Horn, W., and Schenkling, S., *Index Litt. Entom.*, vol. 2, pp. 362–365 (1928); vol. 4, p. 1396 (1929).

[140] *The First Report* appeared in vol. 14 (1855) and the *Fourteenth Report* in vol. 30 (1872). Many of these reports were also published separately.

Tussock moth egg parasite, *Telenomus orygiæ* Fitch.
Waxworm parasite, *Semiotellus clisiocampæ* (Fitch).
Wheat joint worm, *Harmolita tritici* (Fitch)

A portion of his collection is in the New York State Museum, Albany, N. Y., and a few types are in the U. S. National Museum, Washington, D. C.

Fowler, Carroll. Born at Downey, California, June 15, 1875; at present the owner of an orange grove at Duarte, and a deciduous fruit ranch near Modesto, California.

He graduated from the University of California in 1899 with the degree of B. A., and after teaching science at the Alhambra High School in 1899–1900 he returned as assistant in entomology to take charge of C. W. Woodworth's classes during his absence in 1900–1901. During this and his senior year he did a considerable amount of collecting and systematic work on California bees of the family Apidæ. Due to failing eyesight he was compelled to give up his entomological studies. His collection, left at the University, was either destroyed by dermestids or incorporated into some private collection; none of it existed when the author came here in 1914.

The papers contributed by him in such a brief time indicated a very splendid future for him had he been able to continue his studies. They are:

California bees of the genus Nomada, Entom. News, vol. 10, pp. 157–162 (1899).
The Synhalonia *of California*, Can. Entom., vol. 31, pp. 137–138 (1899).
The Habropoda *and* Didasia *of California*, *ibid.*, pp. 283–286 (1899).
Some California bees, Psyche, vol. 8, pp. 405–407 (1899).
The long-tongued bees (*Apidæ*) *of California*, Calif. Agr. Expt. Sta., Rept., 1898–1901, pt. ii, pp. 316–330 (1902).

The California long-tongued bees named by Fowler are:

Nomada interrupta Fowler.
obliqua Fowler.
obscura Fowler.
Synhalonia californica Fowler.
albopilosa Fowler.
Habropoda depressa Fowler.
Didasia nerea Fowler.
cinerea Fowler
Heriades glaucum Fowler.
Calliopsis visaliensis Fowler.
anthidius Fowler.

Fuchs, Carl [141] (Figs. 194, 201). Born at Hanan, Frankfurt-am-Main, Germany, November 24, 1839; died at Alameda, California, June 11, 1914, at the age of seventy-four years, six months and seventeen days. After attending grammar school until fourteen years old and serving an apprenticeship of six years to learn the trade of engraver, he started business as a first class engraver in Paris in 1855 where he remained four years. Another year was spent at Madrid, Spain, and in 1865 he came to the United States where he was employed the first year with Tiffany's in New York. The next year he started a flourishing business of his own. In 1867 he married Marie Debold, who died in 1926 in Oakland, California. An only child died in infancy. He was from his youth interested in insects and particularly beetles. In 1872 he was instrumental with F. G. Schaupp in founding the Brooklyn Entomological Society, which became one of the leading entomological groups of workers in America, although composed almost entirely of German Americans. During the year 1875 Fuchs returned to his home in Germany, taking with him his collection of Coleoptera, by means of which he became acquainted with the great German entomologists, Lucas von Heyden, Edgar von Harold, and Max Gemminger. He also spent a year in Paris, France, where he had access to many of the great French collections of Coleoptera and especially to that of August Sallé.

Upon his return to America he met Charles W. Leng who has given us a splendid word picture of Fuchs in 1876 and again in 1908.

With the idea of exploring new fields for securing beetles, Fuchs sold his business in New York and prepared to go to Java, but an earthquake there made him decide to come to California instead and he arrived, via Panama, in San Francisco in 1884. He set up his business as an engraver and chaser and immediately associated himself with the entomologists at the California Academy of Sciences, becoming a member of the Academy in 1890. To further unite the entomologists in the west he organized at his own home,

[141] Blaisdell, F. E., *Science*, n. s., vol. 40, pp. 91–92 (1914).
Grinnell, Fordyce, Jr., *Bul. Brooklyn Entom. Soc.*, vol. 9, pp. 72–73 (1914).
Dow, R. P., *ibid.*, pp. 72–73 (1914).
Leng, C. W., *Recollections of Charles Fuchs, ibid.*, 73–76, portrait (1914).
Entom. News, vol. 25, p. 384 (1914).
Blaisdell, F. E., et al., *Calif. Acad. Sci.* (4), vol. 8, no. 2, pp. 27–34, pl. 2, portrait (1918).
Pacific Coast Entom. Soc., Proc., vol. 2, no. 4, p. 62 (1924–1925).
Wade, J. S., *Ann. Entom. Soc. Am.*, vol. 21, p. 500 (1928).

on August 15, 1901, the California Entomological Club,[142] with twenty-one charter members. Fuchs was elected president, a position he held until November 27, 1907. V. L. Kellogg was vice-president and F. E. Blaisdell was secretary-treasurer.

In building up a personal collection of Coleoptera his object was to secure all the genera of the entire world. In addition to his fine

FIG. 194.—Carl Fuchs (1839–1914), center, the enthusiastic coleopterist and friend of amateur entomologists. He assisted in organizing the Brooklyn Entomological Society in 1872 and founded the California Entomological Club, the antecedent of the Pacific Coast Entomological Society, in 1901. (Also see Fig. 201.) Frank Ellsworth Blaisdell, M.D. (1862–   ), left, prominent California coleopterist. Beverly Letcher (1864–1905), right, amateur collector of Coleoptera and Lepidoptera. (From a photograph taken at Mill Valley, California, September 7, 1901, and furnished by Dr. F. E. Blaisdell. Handwriting by Fuchs.)

collections of Scarabæidæ and Lucanidæ Fuchs had amassed a specially fine collection of the Scydmænidæ and the Pselaphidæ. Both in the collecting and mounting of these beetles, he was greatly assisted by Mrs. Fuchs, who was always a most efficient helper. Following the almost total destruction of his collec-

[142] See account of same, p. 75. The name was changed to the Pacific Coast Entomological Society at the fifth regular meeting in San Francisco, August 16, 1902.

tion [143] during the San Francisco earthquake and fire in 1906, he was given a position as entomological preparator in the Division of Entomology, University of California, by C. W. Woodworth. He retained this position until the new headquarters of the California Academy of Sciences were established in 1910, when he became assistant curator of insects until he died in 1914.

During his life he was intimately associated with most of the prominent entomologists in America. He was one of the group of older workers including A. S. Packard, E. T. Cresson, Theodore Pergande, A. R. Grote, John L. LeConte, Frederick Blanchard, Samuel H. Scudder, Henry Ulke, Philip Uhler, Geo. H. Horn, and others. In California he was specially intimate with J. J. Rivers, L. E. Ricksecker, F. E. Blaisdell, and E. C. Van Dyke.

Among his accomplishments, in addition to founding the two entomological societies, already referred to, was the starting of the Bulletin of the Brooklyn Entomological Society; the example of neatness and exactness in preparing and naming his specimens; and, the greatest of all were his abounding enthusiasm, congeniality, and helpfulness, which were responsible for inspiring and helping a great many youthful entomologists on their way. He always encouraged and never criticized. His publications were few. The most important one was the Synopsis of the Lucanidæ of North America.[144] He described no new species, but there were a number of interesting California and other beetles named in his honor such as:

Omus fuchsi W. Horn.
Bembidion fuchsi Blaisdell.
Pterostichus fuchsi (Schffr.).
Ægialites fuchsi Horn.
Scydmænus fuchsi Brendel.[145]
Eurystethus fuchsi (Horn).
Eleodes fuchsi Blaisdell.
Aneflus fuchsi Wickham.

A number of beetles from other parts of the United States were also named for him.

[143] Concerning the entomological collections destroyed, E. C. Van Dyke reported the following at the twenty-first quarterly meeting of the Pacific Coast Entomological Society at Alameda, August 25, 1906: "Of private collections, the greatest loss was that sustained by Carl Fuchs of 212 Kearny Street, he having saved only about twenty-two boxes of specimens, these consisting of his generic collection of Coleoptera. His *Eleodes* were in the hands of Blaisdell, and were saved."

[144] *Bul. Brooklyn Entom. Soc.*, vol. 5, pp. 49–60 (1882).

[145] He assembled a fine collection of Scydmænidæ and Pselaphidæ. In mounting he was greatly assisted by Mrs. Fuchs.

Gabb, William More.[146] Born in Philadelphia, Pa., January 20, 1839; died at the same place, May 30, 1878, and was buried in Woodland Cemetery. He was a distinguished geologist and paleontologist, who early became interested in entomology through his associations with the eminent coleopterist George H. Horn in Philadelphia. In 1861 he came to California to become a member of the State Geological Survey of California and assistant to J. D. Whitney.[147] In the same year he joined the California Academy of Sciences and was appointed Curator of Paleontology. In the spring of 1863 he traversed much of the San Joaquin Valley to Fort Tejon and the Sierras in the Mt. Whitney region. In the fall of the same year he was sent to Oregon, Washington Territory, and Vancouver Island. In 1864 he explored northern California and southeastern Oregon. In 1866 he explored the Coast Ranges and in 1867 the White Mountain Range on the boundaries of California and Nevada. In the latter year also he made a trip to Lower California. In 1868 he returned to the East and soon afterwards resigned from the Survey. During his exploration work in California he collected many insects which were turned over to the California Academy of Sciences and the Coleoptera, of which he took a goodly number, were sent to his friend G. H. Horn. As a testimony to his interest in entomology, the tiger beetle, *Cicindela gabbi* Horn, collected by Gabb in southern California, was described in 1866 and the tenebrionid, *Trichiasida gabbi* (Horn), taken in southern and Lower California, was described in 1880, by Horn. For him also H. H. Behr named the butterfly, *Euphydryas gabbi* (Behr), and W. H. Edwards named the butterfly, *Cercyonis gabbi* Edwards.

[146] Dall, W. H., *Biographical Memoir*, Nat. Acad. Sci., Biog. Mem., vol. 6, pp. 347–361, portrait (March, 1909).
Newberry, J. S., *Am. Jour. Sci.* (3), vol. 14, p. 164 (1878).
Nature, vol. 18, p. 285 (1878).
Phil. Public Ledger (June 4, 1878).
Appleton's Cycl. Am. Biog.
Century Cycl. Names.

[147] The butterfly *Euphydryas whitneyi* (Behr), named after the above, is now a synonym of *E. palla* (Behr). *Catocala whitneyi* Dodge, said by F. Grinnell, *Bul. Brooklyn Entom. Soc.*, vol. 9, p. 70 (1914), to have been named for Whitney is named for C. P. Whitney of Milford, N. H. [*Can. Entom.*, vol. 6, p. 126 (1874)].
Also associated with Whitney were W. H. Brewer, J. G. Cooper, William Ashburner, Chester Averill, Charles Hoffman, and Clarence King. Most of these collected either Lepidoptera or Coleoptera which were described by H. H. Behr, George H. Horn, or John L. LeConte. The butterfly, *Euphydryas hoffmani* (Behr) was named for Hoffman.

Grote, Augustus Radcliffe [148] (Fig. 195). Born at Aigburt, near Liverpool, England, February 7, 1841; died at Hildesheim, Hanover, Germany, September 12, 1903. He came to America as a child and lived in New York. Little is known of his life until he began publishing in the Proceedings of the Entomological Society of Philadelphia in 1862.[149] He was, therefore, early associated with E. T. Cresson, Geo. H. Horn, Edward Norton, C. R. Osten Sacken, James Riddings, P. R. Uhler, J. H. B. Bland, J. B. Clemens, W. H. Edwards and others of note. He early began the study of Lepidoptera and was the first in America to undertake the difficult task of working up the Noctuidæ, in the knowledge of which family he held the foremost rank. From 1873-1882 he was intimately connected with the Buffalo Society of Natural History, Buffalo, N. Y., and was Curator on a small salary. Many of his important papers appeared in the first three volumes of the Bulletin of that Society.

Fig. 195.—Augustus Radcliffe Grote (1841-1903), American lepidopterist and first in this country to undertake the difficult task of monographing the family Noctuidæ. (From Entom. News, 1903.)

At Buffalo he became intimate with Coleman T. Robinson, a wealthy New York broker, with whom he described a considerable number of species of moths.

[148] Strecker, H., *Butterflies and moths of N. Am.*, pp. 232-236 (1878).
Can. Entom., vol. 27, p. 1 (1895); vol. 35, p. 294 (1903).
Entom. Soc. Ontario, 16th Ann. Rept., p. 1 (1894); *25th Rept.*, pp. 109-112 (1903); *34th Rept.*, pp. 109-112 (1903).
Entom. Mthly. Mag., vol. 39, p. 256 (1903).
Entom. News, vol. 14, pp. 277-278, portrait (1903); vol. 24, pp. 182-183 (1913).
Bode, W., *Allgemeine Zeits. Entom.*, vol. 9, pp. 1-6, portrait (1904).
Smith, J. B., *Pop. Sci. Mthly.*, vol. 76, p. 471, portrait (1910).
Græf, E. L., *Bul. Brooklyn Entom. Soc.*, vol. 9, pp. 47-56 (1914).
Wade, J. S., *Ann. Entom. Soc. Am.*, vol. 21, p. 502 (1928).
Horn, W., and Schenkling, S., *Index Litt. Entom.*, vol. 4, p. 1401 (1929).

[149] His first paper was *Additions to the catalogue of U. S. Lepidoptera*, vol. 1, pp. 218-219, 345-346, pl. iii (1862). He became a member of this society in 1862.

About 1882 he moved to New Brighton, N. Y., where he remained until he left for Bremen, Germany, in 1884. In 1895 he went to Hildesheim where he lived until his death.

In all Grote published about 100 papers on Lepidoptera in the various proceedings, journals, transactions, bulletins, and reports of the entomological and natural history societies of America and Germany. In 1879 he was editor of the North American Entomologist, which was discontinued after the completion of the twelve numbers of volume I.

His great contribution to America was his excellent works on the Noctuidæ, and he described over 1,000 new species of Lepidoptera, chiefly of this family. His papers are scattered, but several are of general interest:

A synonymical catalogue of North American Sphingidæ, with notes and descriptions (with Robinson, C. T.), Proc. Entom. Soc. Phila., vol. 5, pp. 149–193, 3 pls. (1865).

List of the Lepidoptera of North America (with Robinson, C. T.), Am. Entom. Soc. (1868).

List of the Noctuidæ of America north of Mexico, Buffalo Soc. Nat. Hist., Bul., vol. 2, 77 pp. (1874).

An illustrated essay on the Noctuidæ of North America (London, 1882).

New check list of North American moths (New York, 1882).

Introduction to a study of North American Noctuidæ, Am. Philos., Proc., vol. 21, pp. 134–176 (1883).

His very valuable collection was sold to the British Museum. Many of his types are in the collections of the American Entomological Society, Philadelphia, and the types of the species described by Grote and Robinson are in the American Museum of Natural History, New York City.

Some of the most important species of Western Lepidoptera named by Grote are:

Euxoa excellens (Grote).
Western armyworm, *Chorizagrotis agrestis* (Grote).
Army cutworm, *Chorizagrotis auxiliaris* (Grote).
Olive green cutworm, *Neuria procincta* (Grote).
Yellow-striped armyworm, *Prodenia præfica* Grote.
Brassy cutworm, *Eriopyga rufula* (Grote).
Zimmerman pine moth, *Pinipestis zimmermani* (Grote).

Guenée, Achille [150] (Fig. 196). Born at Chartres, France, January 1, 1809; died at Châteaudun, December 30, 1880. He was one

[150] Hagen, H. A., *Bibliot. Entom.*, vol. 1, pp. 307–309 (1862).
Mabille, Paul, *Ann. Soc. Entom. France*, pp. 5–12 (1881).

of the most distinguished lepidopterists of France and associated with François de Villiers and J. A. Boisduval. He began the study

FIG. 196.—Achille Guenée (1809–1880), French lepidopterist, who described a number of important species of Lepidoptera from this country, some of which were collected in California by P. J. M. Lorquin. (From Charles Oberthur, courtesy American Museum of Natural History.)

of entomology as a boy and after graduating from the College at Chartres and law at Paris, he took up the study of Lepidoptera in

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Fitch, E. A., *Entomologist*, vol. 14, p. 48 (1881).
Entom. Mthly. Mag., vol. 17, pp. 214–216 (1881).
Zoöl. Anz., vol. 4, p. 120 (1881).
Entom., vol. 14, p. 48 (1881).
Grote, A. R., *Papilio*, vol. 1, pp. 31–33 (1881).
Kraatz, G., *Deutsch. Entom. Zeit.*, vol. 25, p. 339 (1881).
Katter, F., *Entom. Nachr.*, vol. 7, p. 68 (1881).
Oberthur, Chas., *Etudes de Lépidoptérologie Comparée*, fasc. 9 (Oct., 1913). Portrait.
Horn, W., and Schenkling, S., *Index Litt. Entom.*, vol. 2, pp. 467–469 (1928); vol. 4, p. 1401 (1929).

earnest. After the loss of an only son and the birth of two daughters he resided at his country seat "Les Chatelliers" at Châteaudun for the remainder of his life. He began writing in 1833 [151] and contributed sixty-three papers and works, some of which were of great size and importance. He is of particular interest to California, because of the large number of moths which he named and described from this state. These were collected by P. J. M. Lorquin for J. A. Boisduval, who turned them over to Guenée.

Some of Guenée's most important works are:

Essai sur une nouvelle classification des Microlépidoptères et catalogue des espèces européennes, Ann. Soc. Entom., France, pp. 105–192, 297–344 (1845) (Tortricina, Crambina, and portions of the Tineina and Hyponomeutidæ).

Spécies général des Lépidoptères, Suites à Buffon, vols. 5–10 (1852–1857) (his greatest work exceeding more than 1,300 closely printed pages, treating the Noctuidæ of the world); *Deltoides et Pyralites*, vol. 8 (1854); *Uranides et Phalenites*, 2 vols. (1857).

Guenée named a great many North American moths, of which some of the important species are:

Red-backed cutworm, *Euxoa ochrogaster* (Guenée).
Cotton cutworm, *Prodenia ornithogalli* Guenée.
Stalk borer, *Papaipema nebris* (Guenée).
Omnivorous looper, *Sabulodes caberata* Guenée.
Walnut looper, *Sabulodes forficaria* Guenée.
Garden webworm, *Loxostege similalis* Guenée.
Douglas fir cone moth, *Zeiraphera diniana* (Guenée).

Gyllenhal, Leonhard [152] (Fig. 197). Born at Algustorp, Westgothland, Sweden, December 3, 1752; died at Hoeberg, Sweden, May 13, 1840, at the age of 88. Eminent Swedish coleopterist. He entered the University of Upsala in 1769, at the age of 17, and studied natural history, specializing particularly in entomology under C. Linnæus, the greatest entomologist of his time. At the age of 20 he entered the service of the army and served from 1772

[151] *Notice of the habits of* Nonagria paludicola, Ann. Soc. Entom., France, vol. 2, pp. 447–453, col. pl. xvi (1833).

[152] *Stett. Entom. Zeit.*, vol. 1, p. 111 (1840).
Holm. Vetensk. Handl., pp. 239–245 (1840).
Swainson, W., *Biog. Zoöl.*, p. 208 (1840).
Hagen, H. A., *Bibliot. Entom.*, vol. 1, p. 327 (1862).
Marseul, S. A. de, *L'Abeille*, vol. 21, p. 74 (1883).
Dow, R. P., *Bul. Brooklyn Entom. Soc.*, vol. 8, p. 70 (1913).
Insecta, vol. 4, no. 37, pp. 35–36, portrait (1914).
Horn, W., *Suppl. Entom.*, no. 12, p. 56 (March 15, 1926).
Horn, W., and Schenkling, S., *Index Litt. Entom.*, vol. 2, p. 493 (1928).

until 1799. His retirement from the army was the beginning of his acquaintance and subsequent relations with Gustav von Paykull, the great Swedish naturalist and entomologist, and he began work on the insects of Sweden. His two great works were:

Insecta Seucia descripta. Classis I. Coleoptera sive Eeutherata, 4 parts, pt. I (Scaris, Leverentz, 1808), 572 pp.; pt. II (*ibid.*, 1910), 660 pp.; pt. III (*ibid.*, 1813), 730 pp.; pt. IV (Leipsig, Fleischer, 1827), 760 pp.

Curculionidæ in Schœnherr, C. J., *Synonymia Insectorum, etc., Fam. Curculionides* (Paris, Roret, 1833–1845), 8 vols.

FIG. 197.—Leonhard Gyllenhal (1752–1840), eminent Swedish coleopterist, who described a number of the most important destructive weevils introduced into this country. (From Insecta, 1914.)

He was a Chevalier of the Royal Order of Wasa, Commander of the Guards, and a member of the Academies of Upsala, Stockholm, and Paris.

His splendid collection is in the Museum at Upsala, Sweden.

Among the many species of Coleoptera described by Gyllenhal are a number of very important ones which have been introduced into America. These and some others worth mentioning are:

Mushroom beetle, *Aglenus brunneus* (Gyll.).
Cribrate weevil, *Brachyrhinus cribricollis* (Gyll.).
Brachyrhinus rugifrons Gyll.
Vegetable weevil, *Listroderes obliquus* Gyll.
Alfalfa weevil, *Hypera postica* (Gyll.).
Cabbage curculio, *Ceutorhynchus rapæ* Gyll.
Polydrusus impressifrons Gyll.
Sitona crinitus Gyll.
    discoidea Gyll.

Hagen, Hermann August [153] (Fig. 198). Born at Königsberg, East Prussia, May 30, 1817; died at Cambridge, Massachusetts,

[153] Hagen, H. A., *Bibliot. Entom.*, vol. 1, pp. 328–332 (1862).
The Harvard Book, vol. 1, pp. 345–346, portrait (1875).
Can. Entom., vol. 25, p. 328 (1893).
Henshaw, S., Entom. Soc. Ontario, *25th Ann. Rept.*, pp. 122–124 (1894); Am. Acad. Arts & Sci., *Proc.*, vol. 29, pp. 419–423, portrait (1894).
Insect Life, vol. 6, pp. 280–281 (1894).

November 9, 1893. First great neuropterist and founder of entomological museums in America. He was educated at the University of Königsberg, where his father, K. N. Hagen, was a professor and where he came under the influence of M. H. Rathke who was Professor of Natural History and with whom he traveled and studied insects later on. He first became a physician in Königsberg where he remained until 1867. From the beginning he was interested in the Neuroptera, used in the broader sense of those days, and his first paper was on the Odonata and appeared in 1839.[154] During his residence in Germany he published many important papers on the Odonata, Neuroptera (as now known), Isoptera, Corrodentia, Plecoptera, Trichoptera, and also on fossil insects and general entomology. The Monographie der Termiten appeared in 1855–1860.[155] Synopsis of the Neuroptera of North America with a list of South American species,[156] appeared in 1861 and his

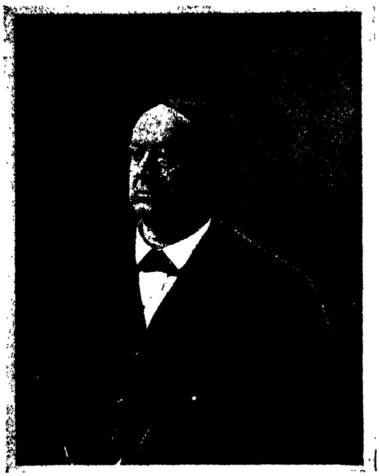


FIG. 198.—Hermann August Hagen (1817–1893), eminent entomological scholar and teacher and one of the first great students of the neuropterous insects. He was the founder of the entomological museums in America. (From The Harvard Book, 1875.)

Calvert P. P., *Entom. News*, vol. 4, pp. 313–317, portrait (1894).
Psyche, vol. 7, p. 35 (1894).
Am. Naturalist, vol. 28, pp. 95–96 (1894).
M'Lachlan, R., *Entom. Mthly. Mag.*, vol. 29, p. 288 (1893); vol. 30, pp. 18–20 (1894).
Seidlitz, G. von, *Duetsch. Entom. Zeit.*, pp. 323–325, portrait (1894).
Osten Sacken, C. R., *Record of my life work in entomology* (Cambridge, Mass., 1903), pp. 74–77.
Smith, J. B., *Pop. Sci. Mthly.*, vol. 76, pp. 472–473, portrait (1910).
Comstock, J. H., *Jour. Econ. Entom.*, vol. 15, pp. 33–34 (1922).
Wade, J. S., *Ann. Entom. Soc. Am.*, vol. 21, p. 502 (1928).
Horn, W., and Schenkling, S., *Index Litt. Entom.*, vol. 2, pp. 495–500 (1928); vol. 4, p. 1402 (1929).

[154] *Verzeichniss der Libellen Ostpreussens*, Preuss, Provinzialbl., vol. 21, pp. 54–58 (1839) (34 species).

[155] *Linnæa Entomologica*, vol. 10, pp. 1–144, 270–325 (1855); vol. 12, pp. 1–342 (1858); vol. 14, pp. 73–128 (1860).

[156] Smithsonian Inst., *Miscl. Coll.*, vol. 8, 20+347 pp. (1861).

greatest work, the Bibliotheca Entomologica,[157] which is a bibliography of all entomological literature up to 1862, appeared in 1862 and 1863.

In 1867 he was invited by Louis Agassiz, Director of the Zoölogical Museum of Harvard University, Cambridge, Mass., to take charge of the Entomological Section. He accepted and came to America in the fall of that year. His was the task of founding the first entomological museum in this country. Admirably prepared, with a splendid educational background, a long profitable experience, an abundance of energy and enthusiasm, the ability to arrange insects in a most marvelous manner; and most of all, the kindly spirit of help to fellow workers, he soon became the recognized head of the profession in America, a prestige he held during the twenty-five years at Cambridge. His work here was of a general nature including systematic and economic entomology, but he retained his interest in the Neuroptera and founded at Cambridge the finest collection of these insects in America. Aside from the things already mentioned he had a marked influence on the study of entomology both in Europe and America. The great Belgian odonatist, Michel Edmond de Selys-Longchamps, was greatly aided and influenced by him and the eminent English neuropterist, Robert M'Lachlan, stated that "I was most emphatically his pupil." In America all of those who were looking forward to an entomological career studied with Hagen if it was possible. This influence was carried to California by A. J. Cook who came West from Michigan in 1893 and C. W. Woodworth in 1886–1888.

He was a member of all the important entomological societies in Europe and America and it is doubtful if any man was more widely and favorably known to the entomologists of the world than was Hagen.

In September, 1890, he was stricken with paralysis which was followed by influenza in January, 1891, and during the remaining years he was rendered helpless and suffered great pain, during which time his work at the museum was faithfully performed by Samuel Henshaw, who became his worthy successor.

Hagen never came West, but he described a number of important Western insects which should be mentioned:

[157] Leipzig, Wilhelm Engelmann, vol I, 12+566 pp. (1862); vol. II, 512 pp. (1863).

Large termite, *Termopsis angusticollis* Hagen.
Nevada termite, *Termopsis nevadensis* (Hagen).
Minor termite, *Kalotermes minor* (Hagen).
Orange psocid, *Cæcilius aurantiacus* (Hagen).
Water prince, *Epicordulia princeps* (Hagen).
Lestes congener Hagen.
stultus Hagen.
unguiculatus Hagen.
Argia vivida Hagen.
Cordulegaster dorsalis Hagen.
Ophiogomphus occidentis Hagen.
severus Hagen.
Æschna multicolor Hagen.
Libellula nodisticta Hagen.
Sympetrum corruptum Hagen.
illotum Hagen.
madidum Hagen.
pallipes Hagen.
Dythemis velox Hagen.
Tramea lacerata Hagen.
Common raphidia, *Raphidia adnixa* Hagen.
Indistinct raphidia, *Raphidia oblita* Hagen.
Stigmatic snake fly, *Inocellia inflata* (Hagen).
Marked mantispid, *Symphasis signata* Hagen.

Haldeman, Samuel Stehman [158] (Fig. 199). Born at Locust Grove, Pennsylvania, August 12, 1812; died at Chickies, Pennsylvania, September 10, 1880. The ablest entomologist among the early Pennsylvania Germans. He worked in all important orders of insects and described many new species. Receiving but two

[158] Hagen, H. A., *Bibliot. Entom.*, vol. 1, pp. 333–334 (1862).
Can. Entom., vol. 12, p. 220 (1880).
Zoöl. Anz., vol. 3, p. 552 (1880).
Am. Naturalist, vol. 14, pp. 755–756 (1880).
Naturaliste, vol. 2, p. 303 (1880).
Nature, vol. 22, p. 517 (1880).
Am. Jour. Sci. and Arts (3), vol. 20, p. 352 (1880).
Hart, C. H., *Penn. Mthly.*, vol. 12, pp. 584–601 (1881).
Am. Acad. Arts & Sci., *Proc.*, vol. 16, pp. 456–457 (1881).
Morris, J. G., Entom. Soc. Ontario, *12th Ann. Rept.*, pp. 14–17 (1881); *Can. Entom.*, vol. 13, pp. 184–186 (1881).
Pop. Sci. Mthly., vol. 21, pp. 289, 395–401, portrait, frontispiece (1882); vol. 76, p. 469, portrait (1910).
Brinton, D. G., Am. Philos. Soc., *Proc.*, vol. 19, pp. 279–285 (1882).
Dall, W. H., Biol. Soc. Wash., *Proc.*, vol. 4, pp. 112–113 (1882).
Lesley, J. P., *Nat. Acad. Sci. Biog. Mem.*, vol. 2, pp. 139–172 (1886).
Nat. Cyclop. Am. Biog., vol. 9, p. 246, portrait (1907).
Entom. News, vol. 23, p. 1, portrait (1912).
Wade, J. S., *Ann. Entom. Soc. Ann.*, vol. 21, p. 502 (1928).
Horn, W., and Schenkling, S., *Index Litt. Entom.*, vol. 2, pp. 502–504 (1928); vol. 4, p. 1402 (1929).

years' training at Dickinson College, he was largely self-educated. He was Professor of Natural History of the University of Pennsylvania from 1851–1855; Professor of Natural History at Delaware College and Professor of Geology and Chemistry at the Delaware Agriculture College from 1855–1869. Because of failing eyesight due to close scientific study he next chose to take up linguistics and was made Professor of Comparative Philology at the University of Pennsylvania from 1869–1880.

FIG. 199.—Samuel Stehman Haldeman (1812–1880) was the ablest of the early Pennsylvania entomologists. He described insects in many orders, especially the Orthoptera, Coleoptera, and Hymenoptera. (From a photograph taken in 1866 and reproduced in Entom. News, 1912.)

He was president of the American Philological Association and president of the American Association for the Advancement of Sciences in 1880.

His most important general papers were Descriptions of New Coleoptera,[159] while the one which included descriptions of new western insects was the Insects of Stanbury's Expedition and Survey of the Great Salt Lake Valley.[160]

Of the many Western insects named by him, the following are the most important:

Coral-legged grasshopper, *Hippiscus corallipes* Hald.
Mormon cricket, *Anabrus simplex* Hald.
Dark sand cricket, *Stenopelmatus fuscus* Hald.
Spotted pine sawyer, *Monochamus maculosus* Hald.
Aphis aphelinid, *Aphelinus mali* (Hald.).
Aleyrodid parasite, *Amitus aleurodinis* Hald.

Harbison, John Stewart [161] (Figs. 106, 107, 200). Born at Chenango, Lawrence County, Pennsylvania, September 29, 1826; died

[159] Acad. Nat. Sci. Phila., *Proc.*, vol. 1, pp. 298–304 (1843); vol. 2, pp. 53–55 (1884); vol. 3, pp. 124–348 (1845); vol. 4, pp. 371–376 (1847); vol. 6, pp. 361–365 (1853); *Trans. Am. Phil. Soc.* (2), vol. 10, pp. 27–66 (1847); *Jour. Acad. Nat. Sci. Phila.* (2), vol. 1, pp. 95–110 (1848); *Silliman's Am. Jour.* (2), vol. 6, 148 pp. (1848).
[160] Philadelphia, pp. 366–378 (1852).
[161] San Diego Honey Interests, *Pacific Rural Press*, vol. 11, p. 339 (May 27, 1876). *Introduction of the honeybee to California*, Am. Bee Jour., vol. 59, pp. 268–270 (1919).

at San Diego, California, October 12, 1912. Pioneer California beekeeper. The fact that he became one of the most successful beekeepers in Pennsylvania and the inventor of the Harbison hive in 1848, is undoubtedly responsible for his successful attempts at beekeeping in California. He first came to California in 1854, arriving in San Francisco via Panama on November 20. In the same year he purchased a swarm of bees from Patrick at San José, thus acquiring descendants of the first bees introduced into California by C. C. Shelton in 1853 (see honeybee, p. 267). In 1855 he purchased a half interest in the William Buck apiary near Sacramento. It is also stated that he had a hive brought directly to the Sacramento Valley in 1856. This appears to be the first successful introduction of the honeybee into this area. With an eye to the future of beekeeping in California, Harbison returned to Newcastle, Pennsylvania, on June 2, 1857, and prepared 67 colonies for shipment to California. These he accompanied in person and carefully tended the bees through the journey. He sailed on November 5, 1857, by steamer to Panama, crossed the Isthmus and continued the journey by boat to San Francisco, where he arrived on November

FIG. 200.—John Stewart Harbison (1826–1912), pioneer beekeeper in California, shipped his first carload of section honey to Chicago in 1873. All of his bees were brought to California via the Isthmus of Panama. (From a photograph taken in 1871 and loaned by G. H. Vansell. Also see Figs. 106 and 107.)

A California pioneer: the interesting career of J. S. Harbison, the first commercial honey producer on the Pacific Coast, *ibid.*, pp. 122–123 (1919).

Pleasants, J. E., *Sixty years of beekeeping in California*, *ibid.*, vol. 61, pp. 7–9, portrait (1921).

John S. Harbison—pioneer Pacific Coast honey producer, Bees and Honey, vol. 8, pp. 159–162, portraits and figs. (1927).

Dodge, Natt M., *Poem*, *ibid.*, p. 153 (front cover).

I am indebted to Fred Hanson, Inspector of Apiaries, San Diego County, for much of the information concerning Harbison.

30. On opening the hives he found that the beemoth, *Galleria mellonella* Zeller, had been very active in the tropics and had utterly destroyed no less than five colonies. Fifty swarms survived the trip and this splendid showing was due to the untiring efforts of the owner in caring for the bees en route. He settled four miles below Sacramento where he resided until 1864. In this year also he improved his hive, which became known as the "California hive," [162] and invented the two pound section box during the period from 1857–1858. In the latter year he again went east for more bees and left Pennsylvania with 114 colonies; 46 of which were from his home county and 68 from Centralia, Illinois. He arrived at Sacramento on January 1, 1859, with 105 living colonies, after traveling a distance of nearly 6,000 miles and at a cost of about sixteen hundred dollars. Soon after this he sold 240 colonies at one hundred dollars each.

Harbison found the Sacramento Valley unsuited to his needs at that time. There was not sufficient pasturage for the bees, many of which were killed by a mysterious disease since found to be due to buckeye poisoning. Accordingly he moved to San Diego County in the spring of 1864 [163] and entered into partnership with R. G. Clark. Their apiaries increased rapidly and at one time they are said to have had 3,750 colonies in twelve different apiaries. In 1873 Harbison shipped his first carload of section honey to Chicago where it sold for twenty-seven cents per pound. In 1874 he took up his residence in Harbison Canyon, San Diego County, where he owned some 480 acres of bee range. In 1876 he had six apiaries and 2,000 hives. In one year he shipped 8 carloads of honey to Chicago. The first honey house in California was built by him in 1880 and is still standing. He wrote one book, The Beekeepers' Directory or The Theory and Practice of Bee Culture (S. F., Bancroft, 1861, xxiii+440 pp., XLVII pls.). The old Harbison bee ranch was bought up by a San Diego real estate firm and has been subdivided and many lots sold for mountain cabin sites; otherwise no use is made of it at this time. His widow, aged eighty-nine, now (1931) resides at 1065 12th Street, San Diego, in the house built by her husband.

[162] The dimensions of this hive were 12 x 12 x 13 inches.

[163] This date is also given as the fall of 1869. *Pac. Rural Press*, vol. 11, p. 339 (May 27, 1876).

Harford, W. G. W. (Fig. 201). Born in Rochester,[164] New York, in 1825; died in Alameda, California, March 1, 1911, at the age of eighty-six years, retaining all his faculties to the end. He was a collector and naturalist particularly interested in shells and spiders [165] and was associated with John B. Trask, Wesley Newcomb, R. E. C. Stearns, John A. Veatch, and other pioneer Pacific Coast naturalists. He was a particular friend of the great botanist, Albert Kellogg. In fact they lived together in a small place on Telegraph Hill, where they kept "batchelors' hall."

FIG. 201.—A group of early California naturalists and entomologists known as the Arthrozoic Club. They are: James J. Rivers, Albert Kœbele, George W. Dunn, James H. Behrens, Carl Fuchs, Thomas L. Casey, and W. G. W. Harford. (A reproduction from Ximena McGlashan, Butterfly Farmer, 1914.)

Harford made a scant living as a preparator at the University of California for four years and at other scientific institutions and was for a time Curator of Conchology at the California Academy of Sciences. In 1867 he was appointed naturalist of the United States Coast Survey Expedition to Alaska under the direction of George Davidson.[166] He collected throughout the Pacific Coast region from southern California to Alaska.

[164] Dall, W. H., *Nautilus*, vol. 25, p. 8 (1911).

Grinnell, F., *P. C. Jour. Entom.*, vol. 3, pp. 578–579 (1911); *Bull. Brooklyn Entom. Soc.*, vol. 9, p. 73, portrait (1914).

McGlashan, Ximena, *The Butterfly Farmer*, vol. 1, no. 7 pp. 99–100, portrait (1914).

[165] His collections of spiders went to Geo. W. and Elizabeth G. Peckham, *Trans. Wisc. Acad. of Sci. Arts and Letters*, vol. 7, Sept. (1888).

[166] His report is published in the *Ann. Rept. of the U. S. Coast Survey for 1867*, Appendix 18.

"He printed little and his life was devoted to helping others in their researches. Being six feet in height, of a Lincolnian gauntness, with a pioneer style of luxuriant beard and bushy eyebrows, his familiar figure will be missed by the old members of the California Academy, to whose meetings he was perennially faithful." [167]

His collection of Coleoptera first went to Albert Kœbele, then to W. M. Giffard, and finally to the Hawaiian Sugar Planters' Experiment Station, Honolulu, where it now is.

The butterfly, *Eurymus harfordi* (Hy. Edwards) (*Colias*), and the beetle, *Gnypeta harfordi* (Casey), were named for him.

Harris, Thaddeus William [168] (Fig. 202). Born at Dorchester, Massachusetts, November 12, 1795; died at Cambridge, Massachusetts, January 16, 1856, in his sixty-first year. Pioneer American economic entomologist.[169]

He studied under W. D. Peck and graduated from Harvard College in 1815 and received a medical degree in 1820, after which he was married and took up the practice of medicine at Milton, Mass. It is not known when he began the study of insects, but it was probably early in his life since both of his parents were interested in natural history. His first article, Upon the Natural

[167] Dall, W. H., *op. cit.*

[168] Morris, J. G., *Am. Jour. Sci. & Arts* (2), vol. 1, pp. 24–27 (1846).

Am. Acad. Arts & Sci., *Proc.*, vol. 3, pp. 224–225 (1856).

Scudder, S. H., Boston Soc. Nat. Hist., *Proc.*, vol. 7, pp. 72, 213–222 (1860); *ibid.*, Occas. Paper, vol. 1, portrait (1869); *Psyche*, vol. 6, pp. 57–60, 121–124, 137–141, 169–172, 185–187, 297–298, 345–346, 357–358 (1891).

Entomological correspondence of T. W. Harris, 375 pp., 4 pls. (1869).

Essex Inst., *Proc.*, vol. 2, pp. 2–3 (1862).

Hagen, H. A., *Bibliot. Entom.*, vol. 1, pp. 343–346 (1862); Boston Soc. Nat. Hist., *Proc.*, vol. 21, pp. 150–152 (1881).

Strecker, H., *Butterflies and moths of N. Am.*, pp. 238–240 (1878).

Winsor, J., *Memorial Hist. Boston*, vol. 4, p. 523 (1881).

Grote, A. R., Entom. Soc. Ontario, *20th Ann. Rept.*, pp. 75–82 (1889).

McKenzie, A., *New England Mag.*, n. s., vol. 8, p. 284, portrait (1893).

Entom. News, vol. 7, p. 1, portrait (1896).

Howard, L. O., *Insect Life*, vol. 7, p. 58 (1894); U. S. Dept. Agr., *Yearbook, 1899*, pp. 136–138, portrait (1900).

Psyche, vol. 14, p. 67 (1907).

Field, W. L. W., *Psyche*, vol. 17, p. 28 (1910).

Smith, J. B., *Pop. Sci. Mthly.*, vol. 76, p. 475, portrait (1910).

Dow, R. P., *Bul. Brooklyn Entom. Soc.*, vol. 8, pp. 106–118 (1913).

Wade, J. S., *The friendship of two old-time naturalists* (*T. W. Harris and H. D. Thoreau*), Scientific Mthly., vol. 23, pp. 151–160 (1926); *Ann. Entom. Soc. Am.*, vol. 21, pp. 502–503 (1928).

Horn, W., and Schenkling, S., *Index Litt. Entom.*, vol. 2, pp. 517–521 (1928); vol. 4, p. 1403 (1929).

[169] He has been called the "Gilbert White of New England."

History of the Salt Marsh Caterpillar, appeared in the Massachusetts Agricultural Repository and Journal, pp. 322–333, 1823. "In 1831 he prepared a catalogue of insects, which was published as an appendix to Hitchcock's Massachusetts Geological Survey."

FIG. 202.—Thaddeus William Harris (1795–1856), pioneer American economic entomologist, published the first comprehensive work on injurious insects in 1841. He was also a systematist of note and named many of our most important species. (After S. H. Scudder, 1869.)

In the same year he became librarian at Harvard. Following this appointment he gave a "course of lectures on natural history with special lectures on botany,"[170] and also "had a private class in entomology, meeting one evening a week and went on field trips Saturday afternoons."[171] One of his students was Samuel H. Scudder who later became one of America's greatest entomologists. His spare time was soon devoted almost exclusively to the study of insects and the gathering of a suitable library. While a "member of a commission to make a more thorough geological and botanical survey of the state he brought together his noted classic, Report on Insects Injurious to Vegetation. This report was first published in full in 1841,[172] the section on beetles having appeared previously in 1838. In 1842 it was reprinted as 'treatise' instead of 'report' and again reprinted in a revised form in 1852. The entire sum received from the state for this labor was one hundred and seventy-five dollars. The work was reprinted by the state after his death in its present form[173] with wood engravings so beautifully executed as to mark an epoch in the art."[174] Harris

[170] Wade, J. S., *op. cit.*, p. 153.

[171] Howard, L. O., *Entom. News*, vol. 22, p. 97 (1911).

[172] *Report on the insects of Massachusetts injurious to vegetation* (Cambridge, Mass., Folsom, Wells, and Thurston, 1841), vi+459 pp.

[173] *A treatise on some of the insects injurious to vegetation* (Boston, C. L. Flint, Editor, Crosby and Nichols, 1862), 640 pp., 278 figs., 8 pls.

[174] The drawings for the steel engravings were made by Antoine Sonrel; those of the wood cuts by Sonrel and J. Burckhardt. The engravings and coloring of the steel plates were done by John H. Richard; those of the wood cuts, by Henry Marsh. The illustrations in general were made under the supervision of Louis Agassiz and their quality has never been surpassed.

Wade, J. S., *op. cit.*, pp. 153–154.

was preceded as a writer on economic entomology in America only by William D. Peck.

In addition to his economic studies Harris did some excellent systematic work and described a number of important economic insects which occur throughout much of the country, among which are the following:

Leather-colored locust, *Schistocerca alutacea* (Harris).
Snail eater, *Scaphinotus cristatus* (Harris).
Potato flea beetle, *Epitrix cucumeris* Harris.
Poplar hawk moth, *Pachysphinx modesta* (Harris).
Spotted halisidota, *Halisidota maculata* (Harris).
Spotted fall webworm, *Hyphantria textor* (Harris).
Reaper dart, *Euxoa messoria* (Harris).
Zebra caterpillar, *Ceramica picta* (Harris).
Fall cankerworm, *Alsophila pometaria* (Harris).
Raspberry root borer, *Bembecia marginata* (Harris).
Cottonwood crown borer, *Ægeria tibialis* (Harris).
Oblique-banded leaf roller, *Archips rosaceana* (Harris).
Raspberry sawfly, *Monophadnoides rubi* (Harris).

He described three species of *Scaphinotus* (*Cychrus*) from the Pacific Coast which were collected by J. K. Townsend in the neighborhood of Vancouver, Washington, in 1834–1835.[175]

His collection was placed in the Museum of the Boston Society of Natural History in 1858 and contains 9,758 specimens, 4,660 species, and 140 types.

Heidemann, Otto [176] (Fig. 203). Born at Magdeberg, Germany, September 1, 1842; died at Washington, D. C., November 17, 1916. He began learning the trade of wood engraving in Leipzig at the age of seventeen, and came to America at the close of the Franco-Prussian War and engaged in engraving at Baltimore. In 1876 he moved to Washington, and soon afterwards illustrated a number of government bulletins. In 1880 he entered the office of G. Wheeler's Geological Survey as a topographical draftsman. In 1883 he was appointed engraver for the U. S. Department of Agriculture in which position he remained for twelve years. During this period

[175] *Boston Jour. Nat. Hist.*, vol. 2, pp. 189–204 (1839).

[176] Howard, L. O., *Proc. Entom. Soc. Wash.*, vol. 18, pp. 201–205, 217–218, 220, portrait (1916).

Psyche, vol. 23, p. 194, portrait, p. 159 (1916).

Entom. News, vol. 28, pp. 1–2, portrait (1917).

Walton, W. R., Heidemann as an Artist, *Proc. Entom. Soc. Wash.*, vol. 23, pp. 94–95 (1921).

Wade, J. S., *Ann. Entom. Soc. Am.*, vol. 21, p. 503 (1928).

FIG. 203.—Otto Heidemann (1842–1916), entomological illustrator and engraver and specialist in the order Hemiptera. (From a photograph loaned by Prof. Lawrence Bruner.)

he was called upon to make engravings of insects, which gave him an interest in entomology lasting the remainder of his life. In 1898 he was appointed assistant and specialist in Hemiptera in the Bureau of Entomology and in 1907 he was made honorary custodian of Hemiptera in the U. S. National Museum. He published thirty-four papers, chiefly on the hemipterous families Miridæ, Tingidæ, and Aradidæ. Many of these appeared in the Proceedings of the Entomological Society of Washington of which society he was a member. He was also a member of the American Association for the Advancement of Science, Biological Society of Washington, American Association of Economic Entomologists, and a charter member of the Entomological Society of America.

His collection was purchased by Cornell University about 1916.

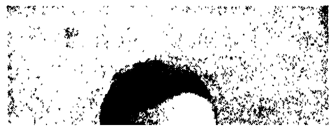
Most of the insects named by him are still obscure, but a few which are of interest are as follows:

Aradus coarctatus Heid.
hubbardi Heid.
Angulate tingid, *Gargaphia angulata* Heid.
Eggplant lacebug, *Gargaphia solani* Heid.
Alder lacebug, *Corythucha pergandei* Heid.
Black grass bug, *Irbisia solani* (Heid.).

Horn, George Henry [177] (Fig. 204). Born at Philadelphia, April 7, 1840; died at Beesley's Point, New Jersey, November 24,

[177] Noland, E. J., Acad. Nat. Sci., Phila., *Proc.*, vol. 49, pp. 505–510, 515–518 (1897).
Nat. Cyclop. Am. Biogr., vol. 7, pp. 502–503 (1897).
Smith, J. B., Acad. Nat. Sci., Phila., *Proc.*, vol. 49, pp. 529–535 (1897); *Science*, n. s., vol. 7, pp. 73–77 (1898); *Pop. Sci. Mthly.*, vol. 76, p. 469, portrait (1910).
Calvert, P. P., *Trans. Am. Entom. Soc.*, vol. 25, append., pp. i–xxiv (1898–1899).
Henshaw, Samuel, *Entomological writings of George Henry Horn and index to*

1897. The eminent entomological preacher, Henry C. McCook, D. D., "delivered an eloquent and appropriate" funeral address. He was buried in his father's lot in Central Laurel Hill Cemetery, Philadelphia. He was educated for a physician, having graduated from the Medical Department of the University of Pennsylvania on



joined the American Entomological Society on July 23, 1860, as a charter member and was a member for thirty-seven years, and president during the last sixteen years of his life. In all he published 265 papers, a number of which were monographic in na-

and Nevada. Here I found them very abundant as well as on the western slope of the Sierras, in the creeks forming the three head branches of Pit River." Other places he mentions as having visited are Yuma, Gila Bend, Maricopa desert, Temescal and Fort Grant, in Arizona.

He returned to Philadelphia in 1866, was elected President of the Entomological Society, December 10, and on December 26, presented to the Academy the first of his results "accumulated during a four years' residence in California and the adjoining territories." [180]

In the spring of 1893, Horn revisited California and was introduced at the meeting of the California Academy of Sciences at San Francisco, May 1. He suffered a paralytic stroke on December 26, 1896, from which he never fully recovered and after which he worked no more.

A British estimation of Horn was given by Roland Trimen, President of the Entomological Society of London, in the following words: "An excellent systematist, Horn chiefly devoted himself to the monographic revision of families and genera, being markedly adverse to the description of isolated new species. His first paper appeared in 1860, in the 'Proceedings' of the Academy of Natural Sciences of Philadelphia; and his work was almost entirely confined to the North-American fauna, the one important exception being his monograph of the Eucnemidæ in the 'Biologia Centrali-Americana.' He was a reserved man and a bachelor; but he made two voyages to Europe in order to visit collections and make the acquaintance of European entomologists, and he has been a welcome visitor at meetings of this Society."

According to Calvert, "His collection of Coleoptera, whose present extent has not been estimated, his entomological library amounting to about 950 volumes, and the sum of five thousand dollars were bequeathed by him to this Society (American Entomological Society), one thousand dollars to the Academy of Natural Sciences, five hundred dollars to the American Philosophical Society." [181]

At the time of his death he was librarian and one of the secretaries of the American Philosophical Society and although nominally connected with the University of Pennsylvania after 1860, as Professor of Entomology, he never taught the subject.

It is obviously impossible to give here a satisfactory list either of the writings of Horn or of the species described by him. For these the reader is referred to the biography by Philip P. Calvert. I cannot refrain, however, from listing some of the most important of his western species.

LeConte's omus, *Omus lecontei* Horn.
Hemphill's snail eater, *Cychrus hemphilli* Horn.
Elegant chariessa, *Chariessa elegans* Horn.
Soldier beetle, *Tegrodera latecincta* Horn.
Alder acmæodera, *Acmæodera amabilis* Horn.

[180] Calvert, Philip P., *op. cit.*, p. iv.
[181] Calvert, Philip P., *op. cit.*, p. xxi.

Western flat-headed borer, *Chrysobothris mali* Horn.
Oak twig girdler, *Agrilus angelicus* Horn.
Buprestid destroyer, *Deretaphrus oregonensis* Horn.
Sordid scymnid, *Scymnus sordidus* Horn.
Catalina ladybird beetle, *Delphastus catalinæ* (Horn).
The kelp beetle, *Phaleria limbata* Horn.
California palm borer, *Dinapate wrighti* Horn.
Crotch's green pine chafer, *Dichelonyx crotchi* (Horn).
Western rose chafer, *Macrodactylus uniformis* Horn.
Mayate, *Cotalpa consobrina* Horn.
Little bear, *Pocalta ursina* (Horn).
Desert corn flea beetle, *Chætocnema ectypa* Horn.
Western flea beetle, *Phyllotreta pusilla* Horn.
Arizona malva miner, *Stenopodius flavidus* Horn.
Amicable weevil, *Mylabris amicus* (Horn).
Limbate weevil, *Mylabris limbatus* (Horn).
Pruinose weevil, *Mylabris pruininus* (Horn).
White bud weevil, *Eupagoderes geminatus* Horn.
Obscure root weevil, *Sciopithes obscurus* Horn.
Small gray leaf weevil, *Thricolepis inornata* Horn.
Yucca weevil, *Scyphophorus yuccæ* Horn.
A great many beetles were named in honor of Horn.

Howard, Leland Ossian [182] (Fig. 205). Born at Rockford, Illinois, June 11, 1857; retired on October 17, 1927, as chief of the Bureau of Entomology after thirty-three years' service in that capacity, and forty-nine years in the service of the Bureau. He is without doubt the greatest entomologist in the world today, and one who is very highly respected by all who know him. He graduated from Cornell University with the degree of B. S. in 1877 and M. S. in 1883. In addition he received the degree of Ph. D., Georgetown, 1896, M. D., George Washington, 1911, LL. D., Pittsburg, 1911, Sc. D., Toronto, 1920. He became assistant entomologist of the U. S. Department of Agriculture under C. V. Riley in 1878, which position he held until he succeeded Riley as chief on June 1, 1894. Since that time he has been the leader in directing the entomological activities in North America. Although primarily interested in medical entomology and parasitology, he has made great and important contributions in systematic and economic entomology and his broad policies in the administration of the Bureau of Entomology have been largely responsible for

[182] Schwarz, E. A., *Proc. Entom. Soc. Wash.*, vol. 18, pp. 183–184 (1916).
Science, vol. 66, p. 391 (Oct. 28, 1927).
Jour. Econ. Entom., vol. 20, pp. 848–849 (1927).
Entom. News, vol. 38, pp. 317–318 (1927).

the excellent work accomplished by that large and efficient governmental organization. As honorary curator of insects in the U. S. National Museum since 1895 he detailed well-qualified scientists to enlarge the national collection of insects and to do the systematic and taxonomic work so essential to the study of economic entomology.

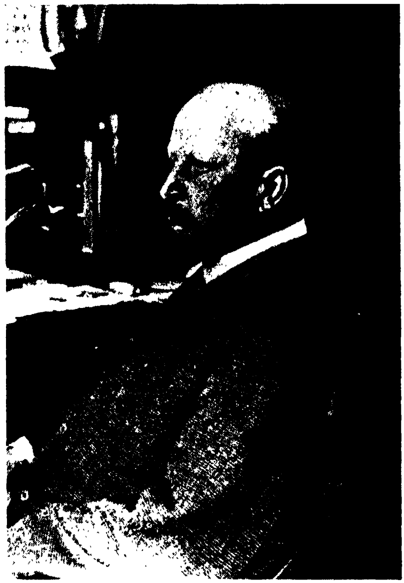


FIG. 205.—Leland Ossian Howard (1857–), America's most noted entomologist and the friend of entomologists the world over. More than any other man he has promoted the development and progress of entomology as a science and a profession in this country. (Photograph on the menu of the Ninth Annual Entomologists' Dinner in his honor, Nashville, Tenn., December 28, 1927.)

Two campaigns with which Howard has been identified are especially widely known. He was a leader in the mosquito crusade. As early as 1893 he published results of experiments showing that certain types of mosquitoes could be controlled by the use of kerosene, and when the mosquitoes were identified as disease carriers he was able to recommend methods of control. His publications on the house-fly dating from 1896 to his book "The House-Fly Disease Carrier" in 1911, were largely responsible for the anti-house-fly crusades all over the world in the last twenty years.

Howard is a member of the National Academy of Sciences, the American Philosophical Society, and the American Academy of Arts and Sciences. He was permanent secretary of the American Association for the Advancement of Science for twenty-two years, and its president in 1920–1921. He has been made honorary member of many foreign scientific societies (twenty-four foreign and twenty American scientific societies) and is the only American member of the Academy of Agriculture of France, and received several decorations, among which are the Cross, Chevalier de la Legion d'Honneur, and the Cross, Officier de l'Ordre du Mérite agricole. He has been a delegate to many international assemblies and an officer of six scientific gatherings (international scientific congresses).

Howard has been peculiarly well trained and suited to the position he so long held, not only in scientific knowledge, but

also in the use of foreign languages, and in a uniquely generous spirit of helpfulness and kindly attitude to all with whom he came in contact. Some of the things he has been trying to do are expressed in his own words as follows:

(1) To impress on everybody the enormous importance of the study of insects—that this study is one of vital importance to humanity.

(2) To show all entomologists that, no matter what aspect of the subject they are studying, they are doing work of vital importance and are greatly helping mankind (this in the effort to prevent all friction between museum and laboratory men and economic workers).

(3) To show the great body of scientific men that entomology and entomologists, including economic entomologists, are doing sound and important scientific work which should command their respect.

(4) To bring about a solidarity among the entomologists of the whole world, on the broad ground that the insect danger is one to all humanity regardless of national affiliation.

All of these points I have been stressing in public addresses, magazine articles, etc., for ten years and more.[183]

He has been a most industrious and prolific writer and the bibliography of his papers to date includes 941 titles. It is impossible to include all of his important contributions, but those best known are:

General Works:

Insect Life, vol. 1 (July, 1888) to vol. 7 (July, 1895), vols. 1–6 edited by C. V. Riley and L. O. Howard; vol. 7, edited by L. O. Howard.

The chinch bug, U. S. Dept. Agr., Div. Entom., Bul. 17, 48 pp., 10 figs. (1888).

A brief account of the rise and present condition of official economic entomology, Insect Life, vol. 7, pp. 55–108 (1894).

Some scale insects of the orchard, U. S. Dept. Agr., Yearbook, 1894, pp. 249–276, figs. 26–42 (1895).

Legislation against injurious insects; a compilation of the laws and regulations in the United States and British Columbia, *ibid.*, Bur. Entom., Bul. 33, 46 pp. (1895).

The San José scale: Its occurrence in the United States, with a full account of its life history and the remedies to be used against it (with Marlatt, C. L.), *ibid.*, Bul. no. 3, n. s., 80 pp., 8 figs., 1 pl. (1896).

The grass and grain joint-worm flies and their allies, *ibid.*, Tech. Ser. 2, 24 pp., 10 figs. (1896).

The gypsy moth in America: A summary account of the introduction and spread of Porthetria dispar *in Massachusetts and the efforts made by the state to repress and exterminate it*, *ibid.*, Bul. 11, n. s., 39 pp., 8 figs. (1897).

The spread of land species by the agency of man, with especial reference to insects, Science, n. s., vol. 6, no. 141, pp. 382–398 (September 10, 1897). (Ad-

[183] In letter dated Washington, D. C., March 7, 1928.

dress as Chairman, Section of Zoölogy, Am. Assoc. for the Advancement of Science.)

The San José scale in 1896-1897, U. S. Dept. Agr., Bur. Entom., Bul. 12, n. s., 31 pp., 1 map (1898).

Danger of importing insect pests, *ibid.*, Yearbook, 1897, pp. 529-552, 43 figs. (1898).

The economic status of insects as a class, Science, n. s., vol. 10, no. 216, pp. 234-247 (February 17, 1899). (Presidential address, Biological Society of Washington.)

Progress in economic entomology in the United States, U. S. Dept. Agr., Yearbook, 1899, pp. 135-156, pl. iii (1900).

Smyrna fig culture in the United States, *ibid.*, Yearbook, 1900, pp. 79-106, 7 figs., pls. i-viii (1901).

The insect book (New York, Doubleday, Page & Co., 1902), xxvii+429 pp., 264 figs., 48 pls.

The United States Department of Agriculture and silk culture, U. S. Dept. Agr., Yearbook, 1903, pp. 137-148, pls. vi-x (1904).

The brown-tail moth and how to control it, *ibid.*, Farmers' Bul. 264, 22 pp., 10 figs. (1906).

The recent progress and present conditions of economic entomology, Science, n. s., vol. 26, no. 675, pp. 769-791 (December 6, 1907). (Principal address, Section of Economic Zoölogy, 7th International Congress of Zoölogy.)

Bouvier, Eugene Louis, *The psychic life of insects*, translated by L. O. Howard (New York, The Century Co., 1922), xvi+377 pp.

The needs of the world as to entomology, Smiths. Inst., Ann. Rept., 1925, pp. 355-372 (1926).

A great menace—The rising tide of insects, Scientific American, pp. 114-115, 8 figs. (February, 1927) (published January 18, 1927).

Public Health and Mosquitoes:

An experiment against mosquitoes, Insect Life, vol. 5, pp. 12-14, 109-110 (1893). (Use of kerosene on breeding pools.)

A contribution to the study of the insect fauna of human excrement, Washington Acad. Sci., Proc., vol. 2, pp. 541-604, pls. xxx-xxxi (1900).

Notes on the mosquitoes of the United States; giving some account of their structure and biology, with remarks on remedies, U. S. Dept. Agr., Div. Entom., Bul. 25, n. s., 70 pp., 22 figs. (1900). (Extended recommendations as to remedies.)

Mosquitoes: how they live, how they carry disease, how they are classified, how they are destroyed (New York, McClure, Phillips & Co., 1901), xv+241 pp., 50 figs., 1 pl.

How insects affect health in rural districts, U. S. Dept. Agr., Farmers' Bul. 155, 20 pp., 16 figs. (1902).

Economic loss to the people of the United States through insects that carry disease, *ibid.*, Bur. Entom., Bul. 78, 40 pp. (1909).

Preventive and remedial work against mosquitoes, *ibid.*, Bul. 88, 126 pp. (1910).

The yellow-fever mosquito, *ibid.*, Farmers' Bul. 547, 16 pp., 6 figs. (1913); *Farmers' Bul. 1354*, 13 pp., 6 figs. (1923).

House flies, *ibid.*, Farmers' Bul. 459, 16 pp., 8 figs. (1911). Revised (with

Hutchison, R. D.), *ibid.*, Bul. 679, 22 pp., 15 figs. (1915); *ibid.*, Bul. 851, 23 pp., 15 figs. (1917).

The mosquitoes of North and Central America and the West Indies (with Dyar, H. G., and Knab, F. (Washington, D. C., Carnegie Inst., 1912–1917), vol. 1, 520 pp., 6 figs., 14 pls. (1912); vol. 2, 150 pls. (1912); vol. 3, pp. 1–523 (1915); vol. 4, pp. 525–1064 (1917).

A fifty-year sketch history of medical entomology, and its relation to public health. A half century of public health—jubilee historical volume of the American Public Health Association, pp. 412–438 (New York, Nov., 1921); Smiths. Inst., *Ann. Rept.*, 1921, pp. 565–685, 10 pls. (1922).

The needs of medical entomology, Amer. Nat., vol. 61, no. 673, pp. 173–179 (1927).

Parasitic Insects:

Report on the parasites of the Coccidæ in the collection of the Department of Agriculture, Commr. of Agr., Rept., 1880, pp. 350–373, pls. xxiii–xxiv (1881).

Description of North American Chalcididæ from the collections of the U. S. Dept. Agr., and of Dr. C. V. Riley, with biological notes (first paper), together with a list of the described N. Am. species of the family, U. S. Dept. Agr., Div. Entom., Bul. 5, 47 pp. (1885).

A generic synopsis of the hymenopterous family Proctotrupidæ, Trans. Am. Entom. Soc., vol. 13, pp. 169–178 (1886).

A brief consideration of certain points in the morphology of the family Chalcididæ, Ann. Address of the President of the Entom. Soc. Wash., Proc., Entom. Soc., Wash., vol. 1, pp. 65–80 (January 6, 1887).

The Hymenopterous parasites of North American butterflies, extracted from Scudder's Butterflies of the Eastern United States and Canada, pp. 1869–1911, 2 pls. (1889).

Biology of the insects of the family Chalcididæ, U. S. Nat. Mus., Proc., vol. 14, pp. 567–588 (1892).

The Hymenopterous parasites of spiders, Proc. Entom. Soc., Wash., vol. 2, no. 3, pp. 290–302, pl. ii (December 9, 1892).

The biology of the hymenopterous insects of the family Chalcididæ, Proc., U. S. Nat. Mus., vol. 14, pp. 567–588 (1892).

The correlation of structure and host-relation among the Encyrtinæ, reprint from Wilder Quarter-Century Book (Ithaca, N. Y., 1893), pp. 177–185.

Revision of the Aphelininæ of North America, U. S. Dept. Agr., Div. Entom., Tech. Ser. 1, 44 pp., 14 figs. (1895).

On the Chalcididæ of the Island of Grenada, B. W. I., Linn. Soc. Journ. Zoöl., vol. 26, pp. 129–178 (1896).

A study of insect parasitism, U. S. Dept. Agr., Div. Entom., Tech. Ser. 5, 57 pp., 24 figs. (1897).

New genera and species of Aphelininæ, with revised table of genera, *ibid.*, Tech. Ser. 12, pt. 4, pp. 69–88 (1907).

The importation into the United States of the parasites of the gypsy and brown-tail moth (with Fiske, W. F.), *ibid.*, Bul. 91, 344 pp., 74 figs., 28 pls. (1911).

The practical use of the insect enemies of injurious insects, U. S. Dept. Agr., Yearbook, 1916, pp. 273–288, 15 figs. (1917).

The parasite element of natural control of injurious insects and its control by man, Jour. Econ. Entom., vol. 19, no. 2, pp. 271–282 (April, 1926).

A great economic waste. What we are doing and what we must do if we would check the ravages of insects, Natural History, vol. 26, no. 2, pp. 124–132, 16 figs., March–April, 1925 (1926).

Some of the important insects named by Howard are:

Polysphincta kœbelei Howard.
Mestocharis wilderi Howard.
Aleyrodid parasite, *Euderomphale flavimedia* (Howard).
Aplastomorpha calandræ (Howard).
California tomocera, *Tomocera californica* Howard.
Common chalcid, *Aphelinus diaspidis* Howard.
Aphelinus fuscipennis Howard.
Marietta mexicana (Howard).
pulchella (Howard).
Encarsia angelica Howard.
coquilletti Howard.
Prospaltella aurantii (Howard).
citrella Howard.
quercicola Howard.
Coccophagus albicoxa Howard.
californicus Howard.
immaculatus Howard.
lunulatus Howard.
ochraceus Howard.
scutatus Howard.
Eretmocerus californicus Howard.
Acerophagus citrinus (Howard).
Pseudaphycus angelicus (Howard).
Metaphycus lounsburyi (Howard).
Microterys flavus (Howard).
Ooencyrtus johnsoni (Howard).
Isodromus iceryæ Howard.
Bothriothorax californicus Howard.
Chrysoplatycerus splendens (Howard).
Hunterellus hookeri Howard.
Decatomidea cooki Howard.
Clover seed chalcis, *Bruchophagus funebris* Howard.
Eurytoma bromi (Howard).
Harmolita californica (Howard).
websteri (Howard).

A few of the very many insects bearing his name are:

Howard's aphis, *Liosomaphis howardi* (Wilson).
The mining scale, *Howardia biclavis* (Comst.).
Howard's bamboo scale, *Chionaspis howardi* Cooley.

Howard's scale, *Aspidiotus howardi* Ckll.
Polynema howardi (Ashm.).
Pelecinella howardi Ashm. (So. America).
Aphelinus howardi D. T.
Eupelmus howardi Olliff (Australia).
Torymus howardi D. T. (America, Granada).
Eurytoma howardi D. T. (America, Granada).

Fig. 206.—Jacob Hübner (1761–1826), famous early German entomologist whose Tentamen, which appeared in 1806, is still the subject of nomenclatorial debate. He will always be remembered as the world's first great lepidopterist. (Photograph of a miniature painted on ivory belonging to the Society of Natural Sciences, Augsburg, Germany, furnished by Dr. Walther Horn.)

Hübner, Jacob[184] (Fig. 206). Born in Augsburg, Germany, June 20, 1761; died in the same city, September 13, 1826. The first great world lepidopterist. Little is known about the early life of this great entomologist, but he began the study of Lepidoptera when young and continued it until his death, one hundred and four years ago. His works were sound and his classification and definitions of genera among the best. Up until his time it was generally held that there were but few genera in the Lepidoptera, a view which he combated and overthrew.

His most important publications are:

Sammlung europaischer schmetterlinge (Augsburg, 1805–1824). (Followed by eight supplemental editions.)
Geschichte europaischer schmetterlinge (Augsburg, 1806–1818).
Sammlung exotischer schmetterlinge (Augsburg, 1806–1824).

[184] Freyer, C. F., *Stett. Entom. Zeit.*, pp. 297–299 (1861).
Lederer, J., *Wien. Entom. Monatschr.*, vol. 5, p. 322 (1861).
Hagen, H. A., *Bibliot. Entom.*, vol. 1, pp. 387–389 (1862).
Grote, A. R., *On Jacob Hübner and his works on the butterflies and moths*, Can. Entom., vol. 8, pp. 131–135 (1876).
Edwards, W. H., *Notes on entomological nomenclature*, *ibid.*, pp. 41–52, 81–94, 113-119 (1876).
Eisinger, *Int. Entom. Zeit.*, vol. 10, p. 125 (1917).
Horn, W., and Schenkling, S., *Index Litt. Entom.*, vol. 2, pp. 584–587 (1928); vol. 4, p. 1407 (1929).

Tentamen determinsationis, digestionis atque denominationis singularum stirpium Lepidopterorum, peritis ad inspiciendum et dijudicandum communicatum (1806). ("An attempt to fix, arrange, and name the individual races of Lepidoptera to experts for examination and the expression of an opinion.")
Verzeichniss bekannter schmetterlinge (Augsburg, 1816), 431 pp.

Although most of Hübner's works were accepted for their face values, there has been much debate over the Tentamen. Many early workers as Ferdinand Oschsenheimer, Friedrich Treitschke, C. P. Zeller, and G. A. W. Herrich-Schæffer of Germany; J. A. Boisduval of France; and T. W. Harris, S. H. Scudder, and A. R. Grote of the United States, accepted it in part, while scores of others pronounced it obsolete. There was in 1876 in this country a debate between Grote on the one side and H. A. Hagen and W. H. Edwards on the other.[185]

In October of 1926, the secretary of the International Commission on Zoölogical Nomenclature announced the fact that application had "been made for the suspension of the international rules, in the case of Hübner's (1806) Tentamen in order to establish its nomenclatorial availability." [186]

The formal nomenclatorial status of this document, involving about one hundred names admitted by some authors as of generic rank, has been under controversy for many years, and opinion of specialists in Lepidoptera is still divided.

The arguments, as submitted, in favor of suspension of rules, maintain that: (1), there are sound reasons both for admitting and for denying recognition to the Tentamen, from the standpoint of interpreting the rules: (2) the evidence pro and con is not sufficiently conclusive to remove the question from debate; (3) the rejection of the Tentamen will produce greater confusion than uniformity, will necessitate a vast amount of undesirable labor and economic loss of time and work; (4) if, on the ground of expediency, the rules can be suspended in this case, the nomenclature of the Lepidoptera, as used for the past thirty years, can be largely maintained.

The Tentamen is one of the most important and most controversial cases ever submitted to the commission. A discussion, with essential bibliographic references, will be found in Smithsonian Misc. Coll., v. 73 (4) (now in press).

In 1927 [187] the International Commission on Zoölogical Nomenclature announced Opinion 97. "Did Hübner's Tentamen, 1806, create monotypic genera?—Hübner's Tentamen, 1806, was

[185] Grote, A. R., *op. cit.*
Edwards, W. H., *op. cit.*
[186] Stiles, C. W., *Science*, vol. 64, p. 381 (1926).
[187] Stiles, C. W., *Science*, vol. 65, pp. 300–301 (1927).

obviously prepared essentially as a manifold manuscript, or as a proof sheet (cf. Opinion 87), for examination and opinion by a restricted group of experts, i.e., in Lepidoptera, and not for general distribution as a record in Zoölogy. Accordingly, the conclusion that it was published in 1806 is subject to debate. Even if the premise be admitted that it was published in 1806, the point is debatable whether the contained binomials should be construed as generic plus specific names. Even if it be admitted that the binomials represent combinations of generic plus specific names, they are essentially *nomina nuda* (as of the date in question) since authors who do not possess esoteric information in regard to them are unable definitely to interpret them without reference to later literature. If published with more definite data at later dates, these names have their status in regard to availability as of date of such republication."

The eminent American lepidopterist, W. J. Holland, defended Opinion No. 97 in an article entitled, Exit Hübner's Tentamen [188] in which he discussed at length the contents of this much debated paper and his reasons for supporting the opinion. His article was ably answered by Wm. T. M. Forbes [189] who raised some perplexing questions which cannot be disposed of by accepting the opinion on nomenclature. The final vote to be taken will probably settle the matter only in the minds of those whose ideas are confirmed, thereby, and will not be the last word!

Aside from the celebrated Tentamen, Hübner will always be remembered for the large number of Lepidoptera named by him. The species of special interest are:

Monarch butterfly, *Danaus menippe* (Hübner).[190]
West coast lady, *Vanessa carye* (Hübner).
Buckeye, *Junonia cœnia* Hübner.
California sister, *Heterochroa bredowi* Hübner.
Bean lycænid, *Strymon melinus* (Hübner).
Chersis sphinx, *Sphinx chersis* (Hübner).
Beet armyworm, *Laphygama exigua* (Hübner).
Cotton leaf worm, *Alabama argillacea* (Hübner).
Forest tent caterpillar, *Malacosoma disstria* Hübner.
Grape leaf folder, *Desmia funeralis* Hübner.
Celery leaf-tier, *Phlyctænia ferrugalis* Hübner.
Chocolate moth, *Ephestia elutella* (Hübner).

[188] *Science*, vol. 66, pp. 4–6 (1927).
[189] *Exit the Tentamen, but . . .*, Science, vol. 66, pp. 396–397 (1927).
[190] The accepted abbreviation of Hübner is Hbn.

Indian meal moth, *Plodia interpunctella* (Hübner).
Platyptilia acanthodactyla (Hübner).
Blackberry leaf skeletonizer, *Schreckensteinia festaliella* Hübner.

The types of his species are in the Museum at Vienna.

Huguenin, Julius Cæsar [191] (Fig. 207). Born at Chaux-de-Fonds, Switzerland, December 20, 1840; died at San Francisco, California, December 7, 1926, within a few days of being 86 years of age. Although trained as a watchmaker, he early became interested in the study of natural history, chiefly birds. He left Switzerland about 1872 and came to America where he first lived at Philadelphia, then Omaha, and finally San Francisco. At the latter place he opened a shop at 413 Kearny Street. He did not become interested in entomology until he began collecting butterflies in San Francisco prior to his joining the California Entomological Club [192] on November 15, 1901. Since that time he spent all of his spare time in building up his collection and in other entomological activities. His early collection and his home and business were destroyed by the earthquake and fire in April, 1906. After residing two months in Oakland he returned to San Francisco and opened a shop and residence on Church Street while rebuilding his new home and place of business at 1810 Fifteenth Street, where he resided until his death. His later collection, with the exception of the butterflies, was donated to the California Academy of Sciences, in 1925.

FIG. 207.—Julius Cæsar Huguenin (1840–1926), amateur collector of butterflies in California. (Photograph furnished by Dr. F. E. Blaisdell, 1927.)

[191] *Pan-Pacific Entom.*, vol. 3, p. 152 (1927).
Van Duzee, E. P., *Proc. Pac. Coast Entom. Soc.*, vol. 2, no. 6, pp. 95–96 (1926–1927).
[192] Changed to the Pacific Coast Entomological Society at the fifth regular meeting in San Francisco, August 16, 1902.

Kellogg, Vernon Lyman [193] (Fig. 208). Born at Emporia, Kansas, December 1, 1867; at present permanent secretary and chairman, Division of Educational Relations, National Research Council, Washington, D. C. One of the leading entomologists and zoölogists in the United States. He graduated from the University of Kansas in 1889 and received the Master's degree there in 1892. He also studied at Cornell University, 1891–1892; in Leipzig, Germany, 1893–1894, 1897–1898; in Paris, 1904–1905, 1908–1909; and received the degree of LL. D. from the University of California in 1919, and from Brown University in 1920; also the degree of Sc. D. from Oberlin College in 1922. In 1890 he became assistant professor and in 1893 associate professor of Entomology at the University of Kansas. In 1893 he became assistant professor of entomology at Stanford University, in 1894 associate professor, and professor in 1896. He retained this chair until 1920 when he accepted the position he now holds. In the years 1915–1919 he was for the most part absent on leave from Stanford assisting Herbert Hoover in the work of the Commission for Relief in Belgium, the U. S. Food Administration and the American Relief Administration. In his work in Europe during the war he received decorations from the governments of Belgium, France, and Poland. Kellogg was not only one of the leading teachers of entomology in the United States, but is unusually gifted as a writer, not alone on insects, but also along many lines in zoölogy as will be seen from his published works, and an authority on the "classification and dis-

FIG. 208.—Vernon Lyman Kellogg (1867–), one of the most gifted teachers and writers in the entomological and zoölogical sciences, and a noted world authority of the Mallophaga. (Photograph by Bachrach, received in 1927.)

[193] *Am. Men of Science* (ed. 3), p. 372 (1921).

tribution of the Mallophaga; the morphology and development of the mouth parts of insects; structure and life history of the dipterous family Blepharoceridæ; the scales of Lepidoptera; phagocytosis in insects; variation in insects; inheritance, artificial parthenogenesis, regeneration, and general biology of silkworms; and the variation, inheritance, and behavior of insects."

Some of his most important works are:

Technical Papers:

The Taxonomic value of the scales of the Lepidoptera, Kan. Univ. Quart., vol. 3, pp. 45–89 (1894).

New Mallophaga, Calif. Acad. Sci., Proc. (2), vol. 6, I, pp. 31–168, 14 pls.; II, pp. 431–548 (1896); III, Calif. Acad. Sci., Occas. Papers, vol. 6, pp. 53–143, 4 pls. (1899). (With B. L. Chapman.)

A problem of distribution, Psyche, vol. 8, pp. 243–247 (1898).

List of N. Am. species of Mallophaga, U. S. Nat. Mus., Proc., vol. 22, pp. 39–100 (1900).

The mouth-parts of the nematocerous Diptera, Psyche, vol. 8, pp. 303–306, 327–330, 346–348, 355–359, 363–365, figs. 1–11 (1899).

The histoblasts (imaginal buds) of the wings and legs of the giant cranefly (Holorusia ribiginosa), *Ibid.*, vol. 9, pp. 246–250 (1901).

The development and homologies of the mouth parts of insects, Am. Naturalist, vol. 36, pp. 683–706 (1902).

Mallophaga of birds of Pacific Coast of N. Am. (with B. L. Chapman), Jour. Entom. Soc., vol. 10, pp. 20–28, iii pls. (1902).

The net-winged midges (Blepharoceridæ) of North America, Calif. Acad. Sci., Proc. (3), Zoöl., vol. 3, pp. 187–226, 4 pls. (1903).

Regeneration in larval legs of silk-worms, Jour. Exp. Zoöl., vol. 1, pp. 593–599 (1904).

Diptera family Blepharoceridæ, Gen. Insectorum, fasc. 56, 15 pp. 2 pls. (1907).

The Mallophaga of the world, Psyche, vol. 15, pp. 11–13 (1908).

Mallophaga, Gen. Insectorum, fasc. 66, 87 pp., 3 pls. (1908).

Mallophaga from California birds (with J. H. Paine), Entom. News, vol. 22, pp. 75–79 (1911).

Mallophaga from birds and mammals (with J. H. Paine), Entom. News, vol. 21, pp. 459–463 (1910).

Distribution of ecto-parasites, Jour. Econ. Entom., vol. 5, pp. 357–358 (1912).

The Anoplura and Mallophaga of N. Am. mammals (with G. F. Ferris), Leland Stanford Jr. Univ. Pub., Univ. Press, Ser. no. 20, 74 pp., 18 figs., 8 pls. (1915).

Books:

Elementary Zoölogy (New York, Henry Holt & Co., 1901), xv+492 pp., 172 figs.

First Lessons in Zoölogy (*ibid.*, 1903), x+363 pp., 257 figs.

American Insects (*ibid.*, 1905), vii+674 pp., 812 figs., 11 col. pls.; (ed. 2, 1908); (ed. 3, 1914), 694 pp., 812 figs., 13 col. pls.

Evolution and Animal Life (with Jordan, D. S.), (New York, D. Appleton & Co., 1907), xi+489 pp.

Darwinism Today (New York, Henry Holt & Co., 1907), xii+403 pp.

Insect Stories (*ibid.*, 1908), vi+298 pp.

The Animals and Man (*ibid.*, 1911), x+495 pp., 244 figs.

Economic Entomology and Zoölogy (with Doane, R. W.), (*ibid.*, 1915), 532 pp., 245 figs.

Nuova, the New Bee (Boston and New York, Houghton Mifflin Co., 1920), 150 pp., 15 illus.

Human Life as the Biologist Sees It (New York, Henry Holt & Co., 1922), 140 pp.

Mind and Heredity (Princeton University Press, 1923), v+108 pp.

Evolution (New York, D. Appleton & Co., 1924), xi+291 pp.

Some representative insects named and described by Kellogg are:

Menopon decoratum Kellogg.
Colpocephalum funebre Kellogg.
Myrsidea dissimilis (Kellogg).
Pseudomenopon pacificum (Kellogg).
Ricinus diffusus (Kellogg).
Philopterus californiensis (Kellogg).
Degeeriella vulgata (Kellogg).
Rallicola advena (Kellogg).
Esthiopterum snodgrassi [194] Kellogg.
Giebelia mirabilis Kellogg.
Blepharocera osten-sackeni Kellogg.

His collection is at Stanford University.

Kirby, William [195] (Fig. 209). The rector of Barham. Born at Witnesham Hall, Suffolk, England, in September, 1759; died at Barham near Ipswich, England, on July 4, 1850. Kirby, known as the father of entomology in England, was educated for the clergy,

[194] Named for R. E. Snodgrass, a student of Kellogg's and a graduate of Stanford University. He is a leading American authority on insect anatomy and physiology and a most excellent entomological draftsman and artist.

[195] Kirby, Wm., and Spence, Wm., *An Introduction to Entomology* (London, 1826), vol. 3, portrait, frontispiece.

Swainson, W., *Bibliogr. of Zoöl.*, p. 225 (1840).

Newman, Edward, *Zoölogist*, vol. 8, pp. 2886–2889 (1850).

Spence, William, and Westwood, J. O., *Trans. Entom. Soc. London*, Proc., vol. 1, n. s., pp. 19–33 (1850–1851).

Freeman, J., *The life of W. Kirby* (Longmans, London, 1852), 506 pp., portrait.

Trans. Entom. Soc., London, n. s., vol. 2, p. 4, portrait (1852–1853).

Hagen, H. A., *Bibliot. Entom.*, vol. 1, pp. 414–417 (1862).

Strecker, H., *Butterflies and moths of N. Am.*, p. 247 (1878).

Dow, R. P., *The rector of Barham and his times*, Bul. Brooklyn Entom. Soc., vol. 8, pp. 68–74 (1913).

graduating from Caius College, Cambridge, in 1781. He acquired the rectory of Barham in 1796 and for sixty-eight years efficiently conducted his ministry and also pursued the study of insects to the extent of becoming one of the most famous entomologists of all time. "Besides being Honorary President of the Entomological Society of London, of which he was a corresponding charter member, Mr. Kirby was president of the Ipswich Museum, Fellow of the Royal, Linnean, Zoölogical, and Geological societies, and honorary member of several foreign societies."

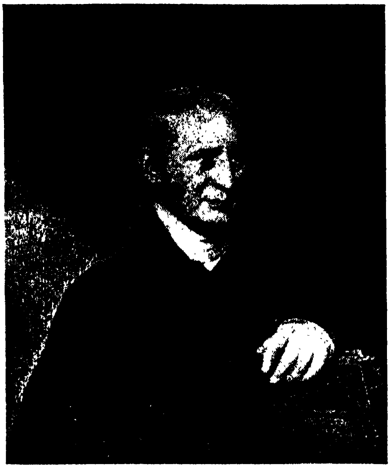


FIG. 209.—William Kirby (1759–1850), the rector of Barham, and one of the greatest British entomologists. He contributed much to the development of entomology in this country and described many of our native insects. (From Kirby and Spence, 1826.)

Kirby was a very capable man, a sound reasoner and careful worker so that his publications have always been looked upon with the highest regard for their accuracy. He did not meet William Spence until 1808 or when he was forty-six years old. The two became fast friends and three years later they began the preparation of the first popular work in English on insects. The first volume of this, An Introduction to Entomology, appeared in 1815. He knew personally or corresponded with L. Gyllenhal, W. D. Peck, Thomas Say, Thaddeus W. Harris, Francis Hope, W. S. MacLea, W. E. Leach, J. F. Stephens, Hamlet Clark, John Curtis, J. C. Dole, Edward Newman, J. O. Westwood, George A. Gray, and John G. Children.

He wrote many entomological papers, the most important of which are:

Monographia Apum Angliæ (Ipswich, 1802), vol. 1, xxii+258 pp.; vol. 2, 288 pp.

Morris, F. J. A., *Can. Entom.*, vol. 47, pp. 384–386 (1915).
Wade, J. S., *Ann. Entom. Soc. Am.*, vol. 21, p. 505 (1928).
Horn, W., and Schenkling, S., *Index Litt. Entom.*, vol. 2, pp. 631–634 (1928); vol. 4, p. 1410 (1929).

Strepsiptera, a new order of insects proposed, etc., Linn. Trans., vol. 11, pp. 88–122 (1811).

An Introduction to Entomology, or Elements of the Natural History of Insects (London, Longman, Hurst, Rees, Orme & Brown, 4 vols., 1815–1826), with plates (with W. Spence). (At least seven editions.)

A Century of Insects, etc., Linn. Trans., vol. 12, pp. 375–453 (1817).

Fauna Boreali-Americana by Sir John Richardson. Insects. (Norwich, 1837), vol. 4; (compiled with notes from the above by C. J. S. Bethune with synonymical notes by George H. Horn, Can. Entom., vols. 2–8 (1870–1876). Issued separately, pp. 156+13.

This last-named paper is of special interest to American entomologists because of the extremely wide distribution of many of the insects described by him from boreal America. In addition to the species described by him a list is added of 103 other North American insects described by Fabricius, Curtis, Children, Linnæus, and others.

His insect collections are now in possession of the Linnean Society and the British Museum, London.

Some of the important insects described by Kirby are:

Grain aphis, *Macrosiphum granarium* (Kirby).
Large back swimmer, *Notonecta insulata* Kirby.
Gloomy buprestid, *Dicerca tenebrosa* (Kirby).
Rustic beetle, *Buprestis rusticorum* (Kirby).
Five-spotted ladybird beetle, *Hippodamia quinquesignata* Kirby.
Yellow velvet beetle, *Leptura chrysocoma* Kirby.
Prickly beetle, *Neoclytus muricatulus* (Kirby).
Goldenrod beetle, *Trirhabda canadensis* (Kirby).
Cerisy's sphinx, *Smerinthus cerisyi* (Kirby).
Celery looper, *Autographa falcifera* (Kirby).
Violet sawfly, *Emphytina canadensis* (Kirby).
Raspberry horntail, *Hartigia cressoni* (Kirby).

Klee, Waldemar G. [196] Born in Copenhagen, Denmark, in 1853; died in Santa Cruz, California, February, 1891, at the early age of thirty-eight. He received a fundamental education in agriculture in his native country before he came to the United States at the age of nineteen. He soon settled in California and became identified with the College of Agriculture of the University of California as head gardener of the agricultural experimental grounds, which position he held for eight years from 1878–1886. During his stay with the University he published a number of papers dealing with his agricultural work and a bulletin on the woolly apple aphis,[197] in

[196] *West Am. Scientist*, vol. 7, pp. 114–115 (1890).
[197] *Woolly apple aphis and its repression*, Calif. Agr. Exp. Sta., Bul. 55 (1886).

which he advocated gas lime as the best remedy for those on the roots of the trees. He was appointed Inspector of Fruit Pests by the California State Board of Horticulture in 1886. During his term with the latter he became interested in the introduction of parasites to control the cottony cushion scale and accordingly addressed letters to Frazer S. Crawford of South Australia concerning the possibilities of such introductions. Crawford reported enthusiastically and offered to send some parasites to California for trial. Klee made arrangements with the Australian Steamship Line to bring over the material. At the same time C. V. Riley was also in correspondence with Crawford and afterwards probably rightly claimed that the parasites sent over in 1888 to Klee and Coquillett were in response to his request.[198] They were apparently the ones liberated by Klee in San Mateo County before Kœbele sailed for Australia on August 20, 1888. By October of that year Klee reported that the adults were still appearing from the hosts, showing that it quickly established itself on the scale, which was then abundant on acacia in the San Francisco Bay region.

In 1888 Klee published two articles on insect pests.[199] The position of State Inspector of Fruit Pests was abolished by the state legislature on January 1, 1889. Two years later he died of consumption. Three children survived him.

Kœbele, Albert [200] (Figs. 116, 117, 201, 210). Born in Waldkirch, Germany, in 1852; died at the same place, December 28, 1924. Nothing is recorded of his early life in his native country. He came to America and was naturalized in 1880, at which time he was a member of the Brooklyn Entomological Society. Here he met C. V. Riley who was so favorably impressed with his entomological

[198] *The parasite was the small fly,* Cryptochætum iceryæ (Williston) (Lestophonus). *Insect Life*, vol. 1, pp. 64, 166 (1888).

Calif. State Bd. Hort., *Third Bien. Rept.*, pp. 179–181 (1888).

[199] *Codling moth remedies*, Calif. State Bd. Hort., Third Bien. Rept., pp. 83–87 (1888).

Parasites, ibid., pp. 179–181 (1888).

[200] Howard, L. O., *Jour. Econ. Entom.*, vol. 18, pp. 556–562 (1925); U. S. Dept. Agr., Bur. Entom., *Mthly. Letter*, no. 131, pp. 1–2 (mimeographed) (1925).

Perkins, R. C. L., *Early work of Albert Kœbele in Hawaii*, Hawaiian Planters' Record, vol. 29, pp. 359–364 (1925).

Swezey, O. H., *Biographical sketch of the work of Albert Kœbele in Hawaii, ibid.*, pp. 364–368, 2 portraits (1925).

Professor Kœbele and his work, Planters' Mthly. (Hawaii), vol. 15, p. 103 (1896).

Van Duzee, E. P. (sketch of Kœbele's work and collection), Calif. Acad. Sci., *Rept. of Director of Museum*, Proc. (4), vol. 15, pp. 530–531 (1926).

Wade, J. S., *Ann. Entom. Soc. Am.*, vol. 21, pp. 505–506 (1928).

work that he gave him an appointment in the Department of Agriculture in the winter of 1881 and assigned him to work on the cotton worm, *Alabama argillacea* Hbn. [*Aletia argillacea* (Hbn.), *A. xylina* (Say)], in Georgia and Florida early in 1882. In the winter of 1882–1883, he accompanied John C. Branner on a cotton exploration in Brazil, "where they remained four months and collected a large amount of interesting material, returning in May, 1883." [201]

On his own request, he was transferred to California in 1885 and made his headquarters in Alameda for the next three years. During this time he collected extensively, worked out the life histories of pests, studied insecticides and made extensive field notes on all phases of his work. In 1886 he first advocated the use of resin wash for the control of the cottony cushion scale, *Icerya purchasi* Mask., which was then ravaging the citrus orchards in southern California. [202] Kœbele also did some experimental spraying work for the control of other insects including the greedy scale, *Aspidiotus camelliæ* Sign., oyster shell scale, *Lepidosaphes ulmi* (Linn.), and the woolly apple aphis, *Eriosoma lanigera* (Hausm.).[203] To combat the cottony cushion scale, the California Board of State Horticultural Commissioners first considered the possibilities of biological control in 1881, but this was subsequently dropped. In 1887 Alexander Craw suggested that D. W. Coquillett be sent to Australia for the purpose of introducing the parasites reported there by F. S. Crawford. C. V. Riley finally determined to send Kœbele and in order to provide the expenses of the trip arranged with the help of Frank McCoppin, U. S. Commissioner to the Melbourne Exposition of California, to send a Commissioner as a representative of the State Department to report on the agricultural features of the Exposition. F. M. Webster [204] was chosen as Commissioner and later followed Kœbele. Kœbele sailed from San Francisco for Australia on August 25, 1888, and immediately upon his arrival

[201] Riley, C. V., U. S. Entom. Comm., *Fourth Rept.*, p. xxxiii (1885).

[202] *Rept. on supplementary experiments on the cottony cushion scale*, U. S. Dept. Agr., Rept., 1886, pp. 558–572 (1887).

[203] *Rept. on experiments against scale insects*, U. S. Dept. Agr., Rept. 1887, pp. 143–147 (1888).

[204] Webster had nothing to do with the introduction of the natural enemies of the cottony cushion scale into California. According to L. O. Howard, "Webster was sent over to make a report to the State Department on the agricultural features of the Melbourne Exposition, and this was done in order that there might be some justification for the expense of Kœbele's expedition from the standpoint of the Department of State."

there, got in touch with Crawford at Adelaide, who showed him the dipterous parasite, *Cryptochætum iceryæ* (Williston) (*Lestophonus*), which he immediately shipped to California along with about 10,000 cottony cushion scale, of which 50% were thought to be parasitized. In all it is claimed that he sent approximately 12,000 specimens of the parasite to California during his brief stay there. Kœbele also found the ladybird beetle, *Rodolia cardinalis* (Mulsant) (*Vedalia, Novius*), which he at once began sending to D. W. Coquillett, who was charged with the duty of caring for, rearing, and distributing the natural enemies in the citrus orchards of southern California. The first lot of 28 beetles arrived in California, November 30, 1888; the second lot of 44 on December 19, 1888; and the third lot of 57 on January 24, 1889. Two other lots followed, the first consisting of 35 specimens on February 21, 1889; and the second numbering 350 on March 20, 1889. Thus a total of 514 adult beetles were received by Coquillett, who by June 12, 1889, reared and distributed 10,555 beetles. The results of this work were phenomenal and at once brought great honor upon Kœbele. At the California State Fruit Growers' Convention held in Los Angeles, November 4–8, 1889, "it was resolved to present to Albert Kœbele, the discoverer of the *Vedalia cardinalis*, a suitable memento, as a token of esteem from the fruit growers of California."

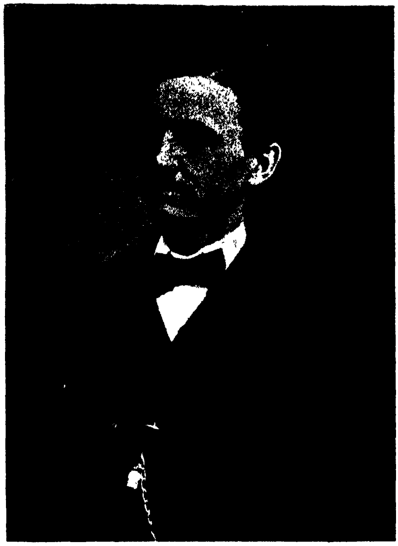


FIG. 210.—Albert Kœbele (1852–1924) is noted for the large number of beneficial insects which he introduced into California and Hawaii for the biological control of insect pests. (From a photograph taken in 1882 and loaned by Prof. Lawrence Bruner. Also see Figs. 116, 117, and 201.)

At the next convention at Santa Cruz in November, 1890, "it was decided that for the present the most suitable memento to be given Mr. Kœbele be a gold watch, chain, and charm, and a set of diamonds, (earrings), for Mrs. Kœbele. Accordingly, by special request, these presents were selected and

purchased by two committees consisting of Commissioners J. L. Mosher, San Francisco, and Fred C. Miles, Penryn, W. H. Robinson of Stockton, Alexander Craw and Chris. Jorgensen of San Francisco. The watch bore the following inscription:

"Presented by the State Board of Horticulture to Albert Kœbele, the discover of the *Vedalia cardinalis*, as a token from the fruit growers of California, November 18, 1890." [205]

The presentation speech was made by Ellwood Cooper, president of the Board. Thirty-six fruit growers subscribed to the fund for the gifts. A small amount of excess cash was also presented with the watch.

He returned to California from his trip in March, 1889, and was again sent to New Zealand, Australia, and adjacent islands by the combined efforts of the California State Board of Horticulture and fruit growers, who raised a fund of five thousand dollars for traveling expenses, and the Division of Entomology, United States Department of Agriculture, which paid his salary. He left San Francisco on his second trip to Australia on August 11, 1891, and arrived at Honolulu where he spent ten days inspecting the insect pests and their natural enemies there. From there he sailed for New Zealand and reached Auckland on September 10, 1891. Here he spent four weeks in search of natural enemies and also liberated three hundred ladybird beetles including *Hippodamia convergens* Guer., *Coccinella californica* Mann., and *Cycloneda munda* (Say) (wrongly listed as *Coccinella sanguinea* L.), and a species of *Raphidia*, all of which he had brought from California. He collected a number of ladybird beetles in New Zealand which were forwarded to California on October 9, 1891, on which day he left for Australia. He spent most of the following seven weeks in New South Wales where he collected a large number of ladybird beetles and other beneficial insects (see pp. 367–371). He left Sydney on April 28, 1892, and arrived at New Caledonia on May 14th. The most interesting insect collected here was a tachina fly parasitic on grasshoppers, large numbers of which he took with him on ice when he left Neumea on May 5th, for the purpose of introducing it into Fiji to prey upon the grasshopper, *Locusta australis* (Sauss.) (*Pachytylus*). Nothing of value was secured during the two months' stay in New Caledonia and Fiji and he returned to Sydney on June 30, 1892. After collecting a number of ladybird beetles and the coccid-eating moth, he left Sydney on July 11, 1892, and arrived at San

[205] Calif. State Bd. Hort., *Ann. Rept.*, 1890, pp. 11–12, 290–292 (1891).

Francisco on August 5, 1892. The results of this trip were the introduction into California of the steel-blue ladybird beetle, *Orcus chalybeus* (Bdv.), the australasia ladybird beetle, *Orcus australasiæ* (Bdv.), the black ladybird beetle, *Rhizobius ventralis* (Er.), the mealybug destroyer, *Cryptolæmus montrousieri* Muls., and Kœbele's ladybird, *Novius kœbelei* (Olliff). Of these only the second failed to become established in our state. The black ladybird now occurs throughout most of the state and is an effective predator of the black scale and other unarmored scales, while the mealybug destroyer is the most effective enemy of mealybugs and last year (1928) approximately forty-two million adults were reared in insectaries and distributed in the citrus orchards of southern California to prey on the citrophilus and citrus mealybugs. Kœbele's ladybird also attacks the cottony cushion scale and often does very good work in controlling it in certain restricted areas.

On the return from his second trip, Kœbele resumed his work at Washington, at which time he wrote the reports [206] of his previous activities.

On September 30, 1893, he received an appointment from the Board of Agriculture and Forestry of the provisional government of Hawaii and resigned his position with the U. S. Department of Agriculture and went to Hawaii where he first studied the insects of that region. During the period 1894–1895 he made a tour of Australia, Ceylon, China, and Japan in search of beneficial insects for Hawaii and introduced there many of the ladybird beetles previously sent to California as well as many more exotic forms, and also a number of hymenopterous parasites. From 1896–1897 he was in Mexico, Arizona, and California in search of ladybird beetles and cutworm enemies. From 1899–1900 he again visited Australia and also spent some time at the Fiji Islands and returned

[206] *Report on the importation of parasites and predaceous insects by the State Board of Horticulture*, Sacramento, Calif., pp. 7–12 (1892).

Sugar cane insects in New South Wales, Insect Life, vol. 4, pp. 385–389 (1892).

Studies of parasitic and predaceous insects in New Zealand, Australia and adjacent islands, U. S. Dept. Agr., 39 pp. (1893).

Experiments with the hop louse in Oregon and Washington, Insect Life, vol. 6, pp. 12–17 (1893).

Report on the status of recent Australian importations, Insect Life, vol. 6, pp. 26–29 (1893).

Coquillett, D. W., *Rept. on the Australian insects sent by Albert Kœbele to Ellwood Cooper and B. M. Lelong*, Insect Life, vol. 5, pp. 251–254 (1893).

Letters written by Kœbele from Australia and California were published in *Insect Life*, vol. 1, p. 165 (1888); vol. 2, p. 252 (1890); vol. 3, p. 71 (1890); vol. 3, p. 468 (1891).

by way of Hongkong, China. A number of important beneficial insects were obtained on this trip.

In 1901–1902 he spent much time in Mexico seeking natural enemies of the lantana plant, which had become a serious pest in Hawaii. In 1903, and before his return to Hawaii, he visited the United States where he consulted L. O. Howard at Washington, D. C., and afterwards met Otto H. Swezey in Ohio, who helped him collect certain dryinid parasites of the leafhoppers which were sent to Hawaii. All of the leafhopper parasites from Ohio failed. He returned to Hawaii in May, 1904, and in the early summer set out with R. C. L. Perkins to search for leafhopper parasites in Australia. Perkins remained only a few months and returned home, leaving Kœbele in Australia. In Queensland he secured the most important egg parasite, *Paranagrus optabilis* Perkins and in Fiji the second most important, *Ootetrastichus beatus* Perkins, which, when established in Hawaii, effectively checked the ravages of the sugar cane leafhopper, *Perkinsiella saccharicida* Kirkaldy, previously accidentally introduced into Hawaii from Queensland. Before returning home, Kœbele again visited Ceylon, China, and Japan where he also obtained many valuable beneficial insects. He became a member of the staff of the Experiment Station, Hawaiian Sugar Planters' Association, about 1903 or 1904.

From 1906–1908 his attention was directed towards collecting parasites of sugar cane insects in Mexico and of the horn fly in Mexico, Arizona, and California.

The latter part of 1908, Kœbele went to Waldkirch, Germany, his boyhood home, where he was born in 1852. This was mainly as an opportunity for the recovering of his health which had been greatly impaired by so much time spent in entomological exploration and research work in fever-infested regions of the tropics. While there, during the summers of 1909–1911, he studied the enemies of the horn fly, and sent much material to Honolulu, but little, if any, success was obtained by this. In 1910, on account of continued failing health, he was relieved from active duty, though still retained as Consulting Entomologist by the H. S. P. A. He continued living in Germany and was there during the Great War, on account of which he was reduced to very meager circumstances and both he and his wife suffered great hardships.[207] At the close of the War, as soon as it was learned of their circumstances, attempts were made by the Hawaiian Sugar Planters' Association to arrange for their return to their home in Alameda, California.[208] By the time that all arrangements were completed,

[207] Two operations were performed on his eyes, one in 1912 or 1913 and the other in March, 1917. An attack of malaria followed the close of the War.

[208] Although naturalized in New York in 1880 it was with great difficulty that he was permitted to return to the United States. Chief in bringing this about was

however, he had become too feeble for undertaking such a trip. He continued to fail and his death finally occurred December 28, 1924, in his 73rd year.[209]

The services rendered to California by Kœbele were of the highest order. He was the first to demonstrate the success of the biological method of controlling insects and the introduction of the vedalia to combat the cottony cushion scale was not only considered to have saved the citrus industry in California, but was the great example which stimulated similar work throughout the world.

In summing up his services to Hawaii Swezey continues:

> The services rendered by Mr. Kœbele and the benefits derived by the agricultural and horticultural interests of Hawaii by his introduction of beneficial insects cannot be estimated in dollars and cents. He made the beginning in this line of work, and much of the time was working alone, yet seventeen species of ladybird beetles were successfully introduced by him and have become valuable factors in keeping reduced such pests as scale insects, mealybugs, plant lice, and leaf-mites. At least six other ladybeetles were introduced and became established, but after a few years disappeared. The eight lantana insects were introduced by him, and about the same number of miscellaneous parasites of Diptera, Lepidoptera, etc. Following Kœbele in this line of work, the other entomologists have introduced a larger number of beneficial insects and some of them have produced more valuable results, but this should not in any way lessen the credit to be given him who was the pioneer in Hawaii in this important phase of entomological work.

In giving a general estimate of Kœbele and his work, L. O. Howard [210] has written:

> What he did for California we know, and we know how he did it. What he did for Hawaii we know, and a just statement of its importance will doubtless be published by Mr. Swezey or Doctor Perkins or both. But it distinctly must be remembered that he was not a scientific authority, that he was not an educated and broadly trained entomologist, but that he was a marvelous collector, the keenest of observers, attentive to the minutest details, and a man of indefatigable industry when in his prime, who seized at once the wonderful opportunities that came to him and who thus became a most productive pioneer in a movement and a method which has already been of great help to humanity in its fight against injurious insects and which promises much to the future.

Besides the papers already mentioned Kœbele wrote ten articles chiefly in the nature of reports on his work in Hawaii. He described

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his former neighbor, E. K. Taylor (1860–1930), a prominent Alameda Attorney and ex-mayor. W. M. Giffard and the Hawaiian Sugar Planters' Association also did all they could to assist.

[209] Swezey, Otto H., *op. cit.*, p. 367.

[210] *Op. cit.*, pp. 561–562.

no insects, but a number of important species bear his name, such as:

Kœbele's ladybird, *Novius kœbelei* (Olliff).
Platyomus kœbelei Blackburn.
Psyllobora kœbelei Nunenmacher.
Artas kœbelei Howard.
Chalcidiscelis kœbelei Ashmead.
Thysanomastix kœbelei Perkins.
Apanteles kœbelei Riley.
Polysphincta kœbelei Howard.
Chelonogastra kœbelei Ashmead.
Dolichozele kœbelei Viereck.

The genus *Kœbelia* was erected in the Cicadellidæ by C. F. Baker in 1897, for the new species *californica.*

His large general collection, which remained at his home in Alameda, was transferred shortly after his death to the California Academy of Sciences, San Francisco, and was presented to the Academy by Mrs. Kœbele in 1926 as a memorial to her late husband. This collection is estimated to contain 100,000 specimens and was secured for the Academy through the efforts of W. M. Giffard of Honolulu and Kœbele's neighbor and friend in Alameda, E. K. Taylor. Giffard retained the Coccinellidæ, the parasitic Hymenoptera and a few small groups which are of special interest to Hawaii.

LeConte, John Lawrence[211] (Fig. 211). Born at New York,

[211] Hagen, H. A., *Bibliot. Entom.*, vol. 1, pp. 459–462 (1862).
Pop. Sci. Mthly., vol. 5, p. 513, portrait (1874).
Henshaw, S., *Dimmock's Special Bibliog.*, no. 1, pp. 1–11 (1878); Trans. Am. Entom. Soc., vol. 9, p. 270 (1881).
Horn, G. H., *Science*, n. s., vol. 2, pp. 783–786, portrait (1883); Am. Philos. Soc., *Proc.*, vol. 21, pp. 290–299 (1884).
Entom. Soc. Ontario, *14th Ann. Rept.*, p. 83 (1883).
Can. Entom., vol. 15, pp. 217–218 (1883).
Edwards, Henry, *Papilio*, vol. 3, pp. 168–169 (1883).
Sallé, A., *Ann. Soc. Entom. France*, pp. 571–576 (1883).
Selys-Longchamps, M. de, *Bul. Soc. Entom. Belg.* (3), no. 39, p. cxlvii (Dec. 1, 1883).
Riley, C. V., *Psyche*, vol. 4, pp. 107–110 (1883).
Schaupp, F. G., *Bul. Brooklyn Entom. Soc.*, vol. 6, pp. i–ix, portrait (1883).
M'Lachlan, R., *Proc. Entom. Soc. London*, p. 34 (1883); *Nature*, vol. 29, p. 128 (1883–1884).
Am. Acad. Arts & Sci., *Proc.*, vol. 19, pp. 511–516 (1884).
Lesley, J. P., et al., Am. Philos. Soc., *Proc.*, vol. 21, p. 290 (1884).
Scudder, S. H., *Trans. Am. Entom. Soc.*, vol. 11, pp. i–xxvii, portrait (1884); *Nat. Acad. Sci. Biog. Mem.*, vol. 2, pp. 261–293 (1886).
Marseul, S. A., de, *L'Abeille Divers*, Ser. 3, no. 47, pp. 185–188 (1884); *L'Abeille*, vol. 22, pp. 124–136 (1884).

May 13, 1825; died at Philadelphia, November 15, 1883. Son of John Eatton LeConte.[212]

He graduated from the College of Physicians and Surgeons in New York in 1846. From 1848 to 1850 he made several journeys to Lake Superior and a trip to California, where during 1850, he collected extensively in San Francisco, San José, San Diego, and along the Mexican border. In 1852 he moved to Philadelphia where he was married in 1861. Other trips were made by him to Central America, Rocky Mountains, Europe, Egypt, and Algiers. At the outbreak of the Civil War he enlisted in the army medical corps as surgeon of volunteers and advanced to the post of medical inspector with the rank of lieutenant-colonel at the close of the war.

FIG. 211.—John Lawrence LeConte (1825-1883) was America's greatest coleopterist and an entomologist of world reputation. He described more of our important species of beetles and weevils than any other person. (From Trans. Am. Entom. Society, 1884.)

From 1878 until his death in 1883 he was assistant inspector of the United States Mint at Philadelphia. He was by far the greatest Coleopterist of this

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Kraatz, G., *Deutsche Entom. Zeits.*, p. 240 (1884).
Sharp, David, *Entom. Mthly. Mag.*, vol. 20, pp. 191–192 (1884).
Parry, C. C., Davenport Acad. Sci., *Proc.*, vol. 4, pp. 229–230 (1885).
Entom. News, vol. 4, p. 185, portrait only (1893).
Benjamin, M., *Science*, n. s., vol. 10, pp. 761–762 (1899); Am. Assn. Adv. Sci., Proc., vol. 48, pp. 450–452 (1899).
Smith, J. B., *Pop. Sci. Mthly.*, vol. 76, p. 469, portrait (1910).
True, F. W., *Hist. First Half Century, National Academy of Science*, pp. 156–158 (1913).
Dow, R. P., *Jour. N. Y. Entom. Soc.*, vol. 22, pp. 185–191 (1914).
Wade, J. S., *Ann. Entom. Soc. Am.*, vol. 21, p. 506 (1928).
Horn, W., and Schenkling, S., *Index Litt. Entom.*, vol. 2, pp. 701–704 (1928); vol. 4, p. 1413 (1929).

According to J. A. G. Rehn the proper writing of his name is LeConte. The accepted form of his name, however, following the scientific name of an insect, is Leconte or the abbreviation Lec.

[212] Major J. E. LeConte (1789–1862) made extensive collections of Coleoptera for G. A. Olivier and Lepidoptera for J. A. Boisduval.

country and named about half of the species known at the time of his death, having described no less than 6,000 nominal species. He not only laid the foundations for the study of Coleoptera, by his careful definitions and synoptic or analytic tables, but by so doing set an example for the entire field of entomology. In this respect he may be classed as one of the greatest entomologists in America.

He was the first president of the Entomological Society of Philadelphia, elected March 14, 1859, at a meeting held in his own home, and served in that capacity throughout the life of this society and the American Entomological Society from 1859–1860 and 1870–1883, or a period of sixteen years. He was a member of all the leading entomological societies in this country and abroad. His first paper entitled: Descriptions of New Species of North American Coleoptera was published in the Proceedings of the Academy of Natural Sciences, Philadelphia, vol. 2, pp. 48–53 (1844) and his last appeared in 1883. In all he wrote one hundred and eighty-four papers including some large monumental works. These papers were largely published in the Proceedings of the Academy of Natural Sciences, Philadelphia, and the Transactions of the American Entomological Society, Philadelphia, but a great many also appeared in other periodicals. He described the Coleoptera taken on the various U. S. geographical and geological and railroad surveys, and from many other sources. John Xantus sent specimens from Fort Tejon and from Lower California. Others who sent him specimens were: S. S. Rathvon, who received specimens collected in the Sacramento Valley by a Mr. Wittick prior to 1859; George Davidson, Puget Sound, Washington; Kennerly, Washington; George Suckley,[213] Oregon; George Gibbs,[214] Washington; J. G. Cooper, Oregon; Newberry, Oregon; L. E. Ricksecker, in Montana, Washington, and California; Henry Edwards in California and the Southwest; A. Bolter in California; O. N. Sanford, California; and others.

[213] George Suckley was born in New York City in 1830 and died there July 30, 1869. He was assistant surgeon of the North Pacific Railroad Survey with J. G. Cooper and was particularly interested in the zoölogy of Washington Territory. With Cooper he wrote the *Natural History of Washington Territory*, Rept. U. S. Railroad, Surv. N. Pac. R. R. Route, vol. 12, book ii, 399 pp., 63 pls. (1860). For him was named the elaterid beetle, *Ludius suckleyi* (Leconte), taken in Oregon, and Suckley's false bumblebee, *Psithyrus suckleyi* Greene, taken at Puget Sound. He also took a number of bumblebees from Oregon which were described by John W. Greene.

[214] For whom LeConte named *Trachypachus gibbsi* Lec. [*Buprestis gibbsi* (Lec.)].

As editor of American Entomology by Thomas Say, New York, 2 vols. (1859), LeConte did a very important and lasting service, not only to Say, but to all entomologists.

The Classification of Coleoptera of North America, with George H. Horn, published in Smithsonian Inst. Miscl. Coll., xxvi, no. 507, 567 pp. (1883), is a monumental work.

With regard to his relations with LeConte, George H. Horn wrote:[215]

> We all knew him as a cultured scholar, a refined gentleman, a genial companion, a true friend. To me he was more. For nearly twenty-five years our association had been of the most intimate nature. I sought his advice and instruction as a neophyte in entomology, finding a welcome which I had no reason to expect. Our friendship ripened to an intimacy never shadowed by the slightest cloud.
>
> Some months after the death of LeConte I considered it a duty to assist in fulfilling his will by suitably preparing his cabinet and transporting it to the Museum at Cambridge. Annually since I have made one or two visits for the more accurate study of its types after a thorough study of my own material had been completed. In that collection I find not only the bare facts, for which I seek, but much besides. In the more than thirty years of our association there is not a box which has not been before us in the topic of discussion or for consultation. Every one recalls its memories, and even particular specimens recall incidents of interest. To me such a visit is, therefore, more than the comparison of specimens, it puts me again in touch with a friend. . . . I regret greatly that many of the traditions of the collection are known only to me. Frequently specimens have something about them indicating their origin, and types from Chaudoir, Mannerheim and others, even including Dejean, may be known thereby. As many of these traditions concern individual specimens it is hardly possible to give any general data. In a collection of the character of that of LeConte it is important that no label attached to a pin, however unimportant it may seem, should be removed.[216]

His collection consisting of over 6,000 types is in the Museum of Comparative Zoölogy, Harvard University, Cambridge, Massachusetts.

LeConte named so many important Coleoptera from all over North America that it is almost impossible to give a representative list of the most important ones for any single section, but the following are at least some of the beetles which should be of interest to western workers:

Horn's omus, *Omus horni* Leconte.
Oregon tiger beetle, *Cicindela oregona* Leconte.

[215] John Lawrence LeConte, *Science*, vol. 2, no. 46, pp. 784–786 (Dec. 21, 1883).
[216] Horn, G. H., *A visit to Cambridge*, Entom. News, vol. 7, pp. 49–50 (1896).

Cordate snail eater, *Scaphinotus cordatus* Leconte.
Common black calosoma, *Calosoma semilæve* Leconte.
Zimmermann's carabid, *Callisthenes zimmermanni* Leconte.
Margined water beetle, *Dytiscus marginicollis* Leconte.
Spinach carrion beetle, *Silpha bituberosa* Leconte.
Pictured rove beetle, *Thinopinus pictus* Leconte.
Pink glowworm, *Microphotus angustus* Leconte.
Large glowworm, *Zarphipis piciventris* Leconte.
Leather-winged beetle, *Podabrus comes* Leconte.
White-spotted blister beetle, *Epicauta pardalis* Leconte.
Infernal blister beetle, *Lytta stygica* (Leconte).
Soldier beetle, *Tegrodera erosa* Leconte.
Western eyed elater, *Alaus melanops* Leconte.
Pheletes canus Leconte.
Placid buprestid, *Chysophana placida* Leconte.
California buprestid, *Polycesta californica* Leconte.
Common acmæodera, *Acmæodera connexa* Leconte.
Sculptured pine borer, *Chalcophora angulicollis* (Leconte).
Adject buprestid, *Buprestis adjecta* (Leconte).
Davidson's beetle, *Dascillus davidsoni* Leconte.
Aquatic dascillid, *Eubrianax edwardsi* (Leconte).
Punctate red spider eater, *Stethorus punctum* (Leconte).
Cloudy scymnid, *Scymnus nebulosus* Leconte.
Variable ladybird beetle, *Exochomus marginipennis* Leconte.
Small darkling ground beetle, *Metoponium abnorme* (Leconte).
Ironclad beetle, *Phlœodes pustulosus* Leconte.
Diabolical ironclad beetle, *Phlœodes diabolicus* Leconte.
Plicate beetle, *Noserus plicatus* Leconte.
Woolly ground beetle, *Cratidus osculans* Leconte.
Oak limb beetle, *Hedobia granosa* Leconte.
Lead cable borer, *Scobicia declivis* (Leconte).
Branch and twig borer, *Polycaon confertus* Leconte.
Spotted limb borer, *Psoa maculata* (Leconte).
Western lyctus, *Lyctus cavicollis* Leconte.
Southern lyctus, *Lyctus planicollis* Leconte.
Fimbriate June beetle, *Pleocoma fimbriata* Leconte.
Behrens' pleocoma, *Pleocoma behrensi* Leconte.
Manzanita serica, *Serica anthracina* Leconte.
Western June beetle, *Phyllophaga errans* (Leconte).
Grapevine hoplia, *Hoplia callipyge* Leconte.
Aspen stag beetle, *Platycerus depressus* Leconte.
Pine sawyer, *Ergates spiculatus* Leconte.
Yellow Douglas fir borer, *Parapachyta spurca* (Leconte).
Lion beetle, *Ulochætes leoninus* Leconte.
Spotted tree borer, *Synaphœta guexi* (Leconte).
Mesquite girdler, *Oncideres pustulatus* Leconte.
Cottonwood twig borer, *Oberea quadricallosa* Leconte.
Milkweed borer, *Tetraopes femoratus* Leconte.

Western fruit beetle, *Syneta albida* Leconte.
Red-shouldered leaf beetle, *Saxinis saucia* Leconte.
Blue milkweek beetle, *Chrysochus cobaltinus* Leconte.
Western beet leaf beetle, *Monoxia consputa* (Leconte).
Western 12-spotted cucumber beetle, *Diabrotica soror* Leconte.
Two-striped leaf beetle, *Luperodes bivittatus* Leconte.
Western potato flea beetle, *Epitrix subcrinita* Leconte.
Live oak weevil, *Deporaus glastinus* Leconte.
Bronze apple tree weevil, *Magdalis ænescens* Leconte.
Black fruit tree weevil, *Magdalis gracilis* Leconte.
California acorn weevil, *Balaninus uniformis* Leconte.
Plum gouger, *Coccotorus scutellaris* Leconte.
Desert arrowweed weevil, *Dinocleus molitor* (Leconte).
Radish weevil, *Cleonus sparsus* Leconte.
Knotweed weevil, *Lixus parcus* Leconte.
Wormwood weevil, *Lixus perforatus* Leconte.
Smartweed weevil, *Lixus mucidus* Leconte.
Jimson weed borer, *Trichobaris mucorea* (Leconte).
Sunflower snout beetle, *Cylindrocopturus adspersus* (Leconte).
Fir tree destroyer, *Scolytus subscaber* Leconte.
One-spined scolytid, *Scolytus unispinosus* Leconte.
Western pine beetle, *Dendroctonus brevicomis* Leconte.
Red turpentine beetle, *Dendroctonus valens* Leconte.
Cypress twig borer, *Phlœosinus cristatus* (Leconte).
Western cedar barkbeetle, *Phlœosinus punctatus* Leconte.
Ash tree barkbeetle, *Micracis suturalis* (Leconte).
Western pine engraver, *Ips plastographus* (Leconte).

Beetles were named for this great man from all over the world and are far too numerous to be mentioned here, but a few of the important California ones are:

Omus lecontei Horn.
Triarthron lecontei Horn.
Trigonurus lecontei Sharp.
Philonthus lecontei Horn.
Ludius lecontei (Candèze).
Hemicrepidius lecontei Candèze.
Scymnus lecontei Crotch.
Hippodamia lecontei Mulsant.

Several birds have been named for LeConte, including the LeConte thrasher, *Toxostoma lecontei lecontei* Lawrence, collected by him at Fort Yuma.

Lelong, B. M.[217] (Fig. 212). Born in Los Angeles, Calif., in 1858; died at Sacramento, Calif., May 3, 1901. He was the son of Martin

[217] Calif. State Bd. Hort., *8th Bien. Rept.*, 1901–1902, p. 9 (1902).
Pacific Rural Press, vol. 61, p. 290 (May 11, 1901).

Lelong, who came to California with J. D. Stevenson's regiment in 1847 and settled in Los Angeles, where B. M. Lelong was born and educated. He early became interested in citrus culture and managed several large citrus orchards in southern California where he became interested in insect pest control and did considerable experimenting in the use of sprays and fumigants. Because of his knowledge of horticulture he was appointed a member of the California State Board of Horticulture by Governor George Stoneman in 1886 and was elected secretary of the board in 1887 which office he held until his untimely death. He was a most arduous worker and a splendid student of horticulture as his many writings testify. The few years of his incumbency were most fruitful and he ably discussed all phases of the broad field covered by the activities of the board.

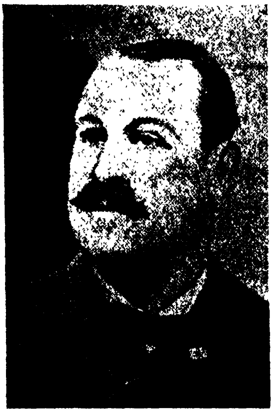

FIG. 212.—B. M. Lelong (1858–1901), as secretary of the California State Board of Horticulture, contributed many important papers on entomology and horticulture in California between 1886 and 1901. (This, the only available likeness, is from the San Francisco Examiner, May 4, 1901.)

The heavy strain of work coupled with an accident, in which he fell from a street car in San Francisco and struck his head so that he was rendered unconscious, affected his mind. Suffering from melancholia he left his office shortly after midnight on May 3, 1901, and committed suicide in the Capitol Park in Sacramento, thus cutting short what promised to be a most fruitful life and depriving the state of "a steadfast and willing friend of the orchardists."

Among his most important contributions are the following:

The olive, the orange, the lemon, deciduous fruits, etc., Calif. State Bd. Hort., Third Bien. Rept., 1887–1888, pp. 31–67 (1888).

A treatise on citrus culture in California, Calif. State Bd. Hort., 96 pp., 17 figs., 1 col. pl (1888) (issued separately).

The olive, ibid., Rept., 1889, pp. 27–114, 26 figs., 2 col. pls. (1890).

Calif. Cult., vol. 16, p. 290 (May 10, 1901).
Examiner, San Francisco, p. 6, portrait (May 4, 1901).
Evening Bee, Sacramento, p. 4 (May 3, 1901).
Record-Union, Sacramento, vol. 101, no. 71, p. 1 (May 3, 1901).

The fig, ibid., Rept. 1889, pp. 115–136, figs. 27–34, col. pl. 3 (1890).
Injurious insects, ibid., Rept. 1889, pp. 115–233, figs. 40–98 (1890).
Beneficial insects, ibid., Rept. 1889, pp. 260–288, figs. 108–138, col. pl. 4 (1890).
The Mission olive, ibid., Rept., 1890, pp. 185–189, 3 pls., 1 col. (1890).
History of the prune, ibid., Rept. 1891, pp. 95–125, 4 pls. (1892).
The blastophaga, ibid., Rept. 1891, pp. 227–259, 6 figs. (1892).
California horticulturally, ibid., Rept. 1892, pp. 13–67 (1892).
California almonds, ibid., Rept., 1892, pp. 33–35, 4 pls. (1892).
California walnut industry, ibid., 5th Bien. Rept., 1895–1896, pp. 77–116, figs. 8–14, pls. xiii–xxii (1896).
Culture of the citrus in California, Calif. State Bd. Hort., 260 pp., many figs., 27 pls. (1900) (issued separately).

Linnæus, Carolus (Linné, Carl von) [218] (Fig. 213). Born at Roeshult, Sweden, May 23, 1707; died near Upsala, Sweden, January 10, 1778.

[218] Pultney, R., *Life and writings of Linnæus* (London, 1781), 425 pp.
Maton, W. G. (London, 1805), 595 pp., 2 pls., 2 portraits.
Millen, L. A. (London, Paris, 1789), 2 vols., 390+400 pp.
Stœver, D. H. (Hamburg, 1792), 2 pts.
Trapp, J. (London, 1794), 38+435 pp., portrait.
Afzetius, A. (Upsala, 1823), 24+248 pp., 6 pls.
Lappe, K. (Berlin, 1826), 24+260 pp., 1 pl., portrait.
Fee, A. L. A., *Vie de Linné*, Mém. Soc. Royale Sci. Lille, pt. 1, 379 pp., 2 portraits (1832).
Sachse, C. T., *Allgem. Deutsche Nat. Zeit.*, vol. 2, pp. 449–459 (1847).
Proc. Linn. Soc. London, vol. 5, p. 5 (1848).
Müller, K., *Nature*, vol. 3, pp. 113–116, portrait (1854).
Hagen, H. A., *Bibliot. Entom.*, vol. 1, pp. 480–485 (1862).
Dohrn, C. A., *Stett. Entom. Zeit.*, vol. 30, pp. 411–425 (1869); vol. 31, pp. 90–97 (1870); vol. 32, pp. 354–370 (1871); vol. 33, pp. 446–462 (1872); vol. 35, pp. 374–386 (1874); vol. 41, pp. 250–255, 333–351 (1880); vol. 42, pp. 195–213 (1881).
Schiödte, J. G., *Nat. Tidsskr.* (3), vol. 7, pp. 333–522 (1870–1871).
Schleiden, M. J., *Westermann's Monatsh.*, vol. 30, pp. 52–68, 162–180, 282–296, 376–392, portrait (1871).
Kiesenwetter, H. von, *Isis*, pp. 43–55, 1872 (1873).
Gistel, J. F. X. (Frankfort, a. M., 1873), 24+371 pp., portrait.
Coquillett, D. W., *Proc. Entom. Soc. Wash.*, vol. 7, pp. 66–68 (1905).
Lönnberg, A. J. E., and Aurivillius, C., *Vetensk. Akad.* (Upsala), 80 pp. (1907).
Harms, J. W., *Naturw. Wochenschr.* (n. F.), vol. 6 (22), pp. 305–312, portraits (1907).
Junk, W. (Berlin, 1907), 19 pp., portrait.
Tullberg, Tycho, *Linnéporträtt* (Stockholm, 1907), 187 pp., 38 figs., 21 pls., 1 col. pl.
Berlese, A., *Gli insetti* (Milano, Kramer, 1909), vol. 1, p. 24.
Miall, L. C., *Early naturalists—their lives and work* (London, Macmillan Co., 1912), pp. 310–336.
Greene, E. L., *Carolus Linnæus* (Phila., C. Sower Co., 1912), 91 pp., portrait.
Lönnberg, A. J. E., *Akad. Bokhandeln* (Upsala), 13+607 pp. (1913).
Aurivillius, C., *Carl von Linné's Bedeutung als Naturforscher u. Arzt* (Jena, G. Fischer, 1909); *Svenska Linné Sällsk. Arsskr.* (Upsala), vol. 5, pp. 97–105 (1922).
Locy, W. A., *Biology and its makers* (N. Y., Henry Holt & Co., 1926), pp. 118–130.
Schuster, J., *Linné and Fabricius* (München, 1928), 26+117+21 pp., portrait.
Nordenskiöld, E., *History of biology* (Knopf, London, 1928), pp. 203–206, 207, 209, 215, 216, 217 (and other references).

This greatest of naturalists was primarily a botanist, but he also did a very great amount of entomological work. He is chiefly of interest to entomologists for the binomial system of nomenclature which made possible the modern classification of insects; for the alary system of separating the orders; for establishing the chronological starting point for the actual naming of insects; and because of the fact that he named and described so many of the commonest and most important species. He traveled and collected considerably throughout Europe, but secured specimens from America and other foreign countries through his friends, associates, and hired collectors.

FIG. 213.—Carolus Linnæus (1707–1778) established the binomial system of nomenclature and was the originator of the modern classification of insects. No scientific name of an insect is considered valid if it appeared before the tenth edition of his *Systema Naturæ* in 1758. It is truly amazing the great number of our common insects which were named by him. (From a painting in the Royal Academy of Science, Stockholm.)

His most important papers on insects are:

Systema Naturæ (ed. 1, 1735) (Classes, Orders, Genera, and Species of insects).

Systema Naturæ (ed. 10, 1758), T. i., 823 pp.; T. ii., pp. 825–1384 (1759).

(This work serves as the starting point in the names of insects. All names antedating it are now considered invalid. It is likely, however, that some day entomologists will recognize many of the species named and so well described prior to this date.)

His early private collection, and by far the most valuable one, was purchased by the Linnean Society of London, while his later accumulations of insects are at the Museum of the University of Upsala.

One needs only consult any work on entomology to get an idea of the many insects in practically every order which were originally

Horn, W., and Schenkling, S., *Index Litt. Entom.*, vol. 3, pp. 735–740 (1928); vol. 4, p. 1414 (1929).

described by this great man. A few of the common important species of mites and insects will serve to demonstrate this.

* Cheese mite, *Tyroglyphus siro* (Linn.).
* Common red spider, *Tetranychus telarius* (Linn.).
* Castor bean tick, *Ixodes ricinus* (Linn.)
* Silver fish moth, *Lepisma saccharina* Linn.
Water springtail, *Podura aquatica* Linn.
* European earwig, *Forficula auricularia* Linn.
Small earwig, *Labia minor* (Linn.).
Carolina locust, *Dissosteira carolina* (Linn.).
American cockroach, *Periplaneta americana* (Linn.).
* Oriental cockroach, *Blatta orientalis* Linn.
* Common or German cockroach, *Blattella germanica* (Linn.).
* Guinea pig louse, *Gliricola porcelli* (Linn.).
* Common hen louse, *Menopon gallinæ* Linn.
* Biting duck louse, *Trinoton querquedulæ* (Linn.).
* Cattle red louse, *Trichodectes bovis* (Linn.)
* Biting horse louse, *Trichodectes equi* Linn.
* Biting sheep louse, *Trichodectes ovis* Linn.
European thrips, *Thrips physapus* Linn.
Striped or banded thrips, *Aeolothrips fasciatus* (Linn.).
* Crab louse, *Phthirius pubis* Linn.
* Sucking horse louse, *Hæmatopinus asini* (Linn.).
* Hog louse, *Hæmatopinus suis* (Linn.).
* Long-nosed ox louse, *Linognathus vituli* Linn.
Rose leafhopper, *Empoa rosæ* (Linn.).
Knotweed psyllid, *Aphalara calthæ* (Linn.).
* Boxwood psyllid, *Psyllia buxi* (Linn.).
Thistle aphis, *Anuraphis cardui* (Linn.).
Bean or dock aphis, *Aphis rumicis* Linn.
* Cabbage aphis, *Brevicoryne brassicæ* (Linn.).
* Rose aphis, *Macrosiphum rosæ* (Linn.).
* Currant aphis, *Myzus ribis* (Linn.).
* Soft brown scale, *Coccus hesperidum* Linn.
* Cottony maple or vine scale, *Pulvinaria vitis* (Linn.).
* Oyster shell scale, *Lepidosaphes ulmi* (Linn.).
Common damsel bug, *Nabis ferus* (Linn.).
Jagged ambush bug, *Phymata erosa* (Linn.).
* Common bedbug, *Cimex lectularius* Linn.
Tarnished plant bug, *Lygus pratensis* (Linn.).
Carolina tiger beetle, *Tetracha carolina* (Linn.).
Hairy rove beetle, *Creophilus maxillosus* (Linn.).
Eyed elater, *Alaus oculatus* (Linn.).
Aurulent beetle, *Buprestis aurulenta* Linn.[219]

* Introduced into California.

[219] This beautiful beetle was named by Linnæus [*Syst. Naturæ*, xii, p. 661 (1867)], but it is not known how or where he procured the specimens.

Buffalo carpet beetle, *Anthrenus scrophulariæ* (Linn.).
* Larder beetle, *Dermestes lardarius* Linn.
Dried fruit beetle, *Carpophilus hemipterus* (Linn.).
* Saw-toothed grain beetle, *Oryzæphilus surinamensis* (Linn.).
* White-marked spider beetle, *Ptinus fur* Linn.
* Drug store beetle, *Sitodrepa panicea* (Linn.).
* Asparagus beetle, *Crioceris asparagi* (Linn.).
Grape root worm, *Adoxus obscurus* (Linn.).
* Pea weevil, *Mylabris pisorum* (Linn.).
* Strawberry root weevil, *Brachyrhinus ovatus* (Linn.).
* Granary weevil, *Sitophilus granarius* (Linn.).
* Rice weevil, *Sitophilus oryzæ* (Linn.).
* European house mosquito, *Culex pipiens* Linn.
Large beefly, *Bombylius major* Linn.
Large syrphid, *Lasiophthicus pyrastri* (Linn.).
* Nose bot fly, *Gastrophilus hæmorrhoidalis* (Linn.).
* Sheep bot, *Oestrus ovis* Linn.
* Greenbottle fly, *Lucilia cæsar* (Linn.).
* House fly, *Musca domestica* (Linn.).
* Stable fly, *Stomoxys calcitrans* (Linn.).
* Frit fly, *Oscinis frit* (Linn.).
* Sheep tick, *Melophagus ovinus* (Linn.).
* Human flea, *Pulex irritans* Linn.
Pipevine swallowtail, *Papilio philenor* Linn.
* Cabbage butterfly, *Pieris rapæ* (Linn.).
Passion vine butterfly, *Dione vanillæ* (Linn.).
Mourning cloak, *Aglais antiopa* (Linn.).
Red admiral, *Vanessa atalanta* (Linn.).
Painted lady, *Vanessa cardui* (Linn.).
* Chinese silkworm, *Bombyx mori* Linn.
* Beemoth, *Galleria mellonella* (Linn.).
* Meal snout moth, *Pyralis farinalis* Linn.
* Imported currant borer, *Ægeria tipuliformis* (Linn.).
* Codling moth, *Carpocapsa pomonella* (Linn.).
Polished horntail, *Sirex juvencus* (Linn.).
Pigeon tremex, *Tremex columba* (Linn.).
Apanteles glomeratus (Linn.).
Eremotylus macrurus (Linn.).
* Blastophaga, *Blastophaga psenes* (Linn.).
* Cabbage butterfly parasite, *Pteromalus puparum* (Linn.).
Pavement ant, *Tetramorium cæspitum* (Linn.).
American black ant, *Lasius niger* (Linn.).
Fuscous ant, *Formica fusca* Linn.
Blue mud wasp, *Chalybion cæruleum* (Linn.).
White-faced hornet, *Vespula maculata* (Linn.).
* Honeybee, *Apis mellifica* (Linn.).

* **Introduced into California.**

Loew, Hermann[220] (Fig. 214). Born in Weissenfels, Germany, July 19,[221] 1807; died in Halle, Germany, April 21, 1879. One of the world's greatest dipterists and may be said to be the father of dipterology. He graduated from the University of Halle and later taught mathematics, philology, and natural history. In 1841–1842 he accompanied the noted geographers, Heinrich Kiepert and August Schœnborn, to the Far East. The results of this, his only extensive trip, were partly communicated to C. H. Burmeister and Alex. von Humboldt and the remainder used in his later publications. In 1848 he was elected to the German Parliament in Frankfort am Main. In 1850 he was appointed Director of the Royal "Realschule" in Meseritz. This institution was very greatly strengthened by him and afterwards became a gymnasium. In

FIG. 214.—Hermann Loew (1807–1879), the great German dipterist, who may be said to be the father of dipterology. He described many important species of flies from this country. (After C. R. Osten Sacken, 1903.)

[220] Hagen, H. A., *Bibliot. Entom.*, vol. 1, pp. 489–493 (1862).
Krause, Ernst (Carus Sterne), *Deutsch. Entom. Zeits.*, vol. 23, pp. 419–421 (1879).
Entom. Mthly. Mag., vol. 16, p. 46 (1879).
Entom. Nachr., vol. 5, p. 146 (1879).
Zoöl. Anz., vol. 2, p. 336 (1879).
Kowarz, F., *Verh. Zoöl-bot. Ges. Wien*, vol. 29, pp. 45–47 (1879).
Naturaliste, vol. 1, p. 63 (1879).
Am. Nat., vol. 13, p. 798 (1879).
Osten Sacken, C. R., *Verh. Zoöl.-bot. Ges. Wien*, vol. 34, p. 455 (1884); *Record of my life work in entomology* (Cambridge, Mass., 1903), pp. 28–35, 44–74, 77–137, 144–153, 158–164, portrait.
Speiser, F., *Entom. Wochenbl.*, vol. 24, p. 129 (1907).
Wade, J. S., *Ann. Entom. Soc. Am.*, vol. 21, p. 507 (1928).
Horn, W., and Schenkling, S., *Index Litt. Entom.*, vol. 3, pp. 744–750 (1928); vol. 4, p. 1414 (1929).

[221] Hagen and the *Entomological Magazine* give July 7 as the date of his birth, whilst Ernst Krause gives July 19.

1868 he received a pension which gave him the desired freedom to devote his energies to Diptera and he moved to Guben, where his work was uninterrupted until he accepted a seat in the Legislature in Berlin for the Sorau-Guben district from 1873–1876. In the latter year he suffered a paralytic stroke from which he never recovered. Loew was a prolific writer and published a great many papers on various entomological subjects but mostly on Diptera. Many of these were fundamental in nature. He was for many years in touch with C. R. Osten Sacken and other dipterologists in North America and contributed the following papers of interest to this country:

Die nordamerkanischer Arten der Gattungen Tetanocera *und* Sepedon, Wien Entom. Monatsschr., vol. 3, pp. 289–300 (1859).

Diptera Americana ab Osten-Sackenio collecta Decas. 1, Ibid., vol. 4, pp. 79–84 (1860).

Diptera Americæ septentrionalis indigena, Berliner Entom. Zeitscher., vol. 5, pp. 252–306, tab. I (1861) to X (1872). (Also pub. separately in two volumes.)

Monographs on North American Diptera, Smithsonian Inst., Washington, D. C., I (1862), II (1864), III (1872).

Neue nordamerikanische Dasypogonina, Berliner Entom. Zeitschr., vol. 8, pp. 353–377, 378–384 (1874).

Beschreibungen neuer amerikanischen Dipteren, Zeitschr. f. ges. Naturwiss, vol. 48, pp. 317–340 (1876).

Neue nordamerikanischen Ephydrinen, ibid., vol. 50, pp. 192–203 (1878).

Through the efforts of Osten Sacken, Loew's collection of North American Diptera was acquired by the Museum of Comparative Zoölogy, Cambridge, Massachusetts. It contained types of approximately 1,300 species, also 330 other species identified by Loew, and 1,200–1,300 undescribed and unidentified species. His own private collection is in the Zoölogical Museum in Berlin and a portion in the Museum at Vienna, Austria.

Of the large number of North American flies named by Loew, the following are of importance:

Wood-boring tipulid, *Ctenophora angustipennis* Loew.
Giant crane fly, *Holorusia rubiginosa* Loew.
Blossom fly, *Bibio nervosus* Loew.
Hairy March fly, *Bibio hirtus* Loew.
Spotted soldier fly, *Stratiomyia maculosa* Loew.
Golden gadfly, *Silvius gigantulus* Loew.
Anthrax molitor Loew.
Zenillia futilis (O. S.).
Burnt tachina, *Blepharipeza adusta* Loew.

Mexican orange maggot, *Anastrepha ludens* (Loew). (Found in Texas in 1927.)
Parsnip leaf miner, *Acidia fratria* (Loew).
Currant or gooseberry fruit fly, *Epochra canadensis* (Loew).
White-banded cherry fruit fly, *Rhagoletis cingulata* Loew.
Pomace fly, *Drosophila ampelophila* Loew.
Asparagus miner, *Agromyza simplex* Loew.
Wheat sheath maggot, *Cerodonta dorsalis* Loew.

Other prominent European dipterologists, who named important species of American flies, are:

Fallén, Carl Friedrich, 1764–1830. Swedish entomologist and professor at Lund. He named the following species:
Paragus tibialis (Fallén).
Arcuate syrphid, *Syrphus arcuatus* (Fallén).
Lesser bulb fly, *Eumerus strigatus* (Fallén).
Bonnetia comta (Fallén).
Zenillia affinis (Fallén).
confinis (Fallén).
vulgaris (Fallén).
Protocalliphora azurea (Fallén).
Squash root maggot, *Muscina assimilis* (Fallén).
Muscina stabulans (Fallén).
Serpentine leaf miner, *Agromyza scutellata* Fallén.
Agromyza æniventris Fallén.
Phytomyza obscurella Fallén.
Leucopis griseola Fallén.
He also named the six-spotted leafhopper, *Cicadula sexnotata* (Fallén) and the dock falseworm, *Ametastegia glabrata* (Fallén).

Meigen, Johann Wilhelm, 1763–1845. A German entomologist and teacher at Stolberg, Germany. He described and named the following important economic Diptera:
Red-legged phorid, *Aphiochæta rufipes* Meigen.
Nemorilla maculosa (Meigen).
Bluebottle fly, *Calliphora erythrocephala* (Meigen).
Greenbottle fly, *Lucilia sericata* Meigen).
Black blowfly, *Phormia regina* Meigen.
Onion maggot, *Hylemyia antiqua* (Meigen).
Chloropisca glabra (Meigen).
Wild parsnip leaf miner, *Phytomyza albiceps* Meigen.
Wheat sheath stem maggot, *Cerodonta femoralis* Meigen.

Wiedemann, Christian Rudolph Wilhelm, 1770–1840. German entomologist and zoölogist and professor at Kiel. Some important flies described by him are:
The American syrphid, *Syrphus americanus* Wied.
Sturmia distincta (Wied.).

Robust tachina fly, *Peleteria robusta* (Wied.).
Pegomyia bicolor (Wied.).
Mediterranean fruit fly, *Ceratitis capitata* (Wied.).
South American fruit fly, *Anastrepha fraterculus* (Wied.).
Sunflower peacock fly, *Strauzia longipennis* Wied.
Paracantha culta Wied.
Spotted root fly, *Euxesta notata* (Wied.).

Lorquin, Pierre Joseph Michel [222] (Fig. 215). Born in Valenciennes, France, July 2, 1797; died in Paris, France, February 8, 1873. "He entered the University of Douay, graduated with honors, when he entered a notary's office as first clerk and rose steadily until he obtained papers which entitled him to practicing his profession. In 1840 he removed to Paris where he was referee in the High Tribunal; this was a high office at that time, and the occupant was of considerable importance. In 1848 the Revolution broke out and Lorquin applied for a position in Algiers; he obtained this and took up his residence at that place; this was his first most important voyage, and here he collected a great amount of valuable and interesting lepidopterological material.

"Hearing of the discovery of gold in California in 1850, he relinquished his position and set out for the new Eldorado; but gold was not first in his mind, it was the thought of the virgin field he would be the first to explore scientifically, and the number of new things he would be sure to get." [223]

He was a lawyer, naturalist, and traveler, and was the first great resident entomological collector in California, having been attracted by the gold rush in 1849. His family arrived in 1852 and he remained until 1859. He was an intimate friend of the great French lepidopterist, J. A. Boisduval, who was family physician for the Lorquins. In California Lorquin found an unexplored field for Lepidoptera and he set to work to supply Boisduval with specimens. Being of strong and robust constitution and a great walker, he

[222] Boisduval, J. A., *Ann. Soc. Entom. France* (5), vol. 3, pp. 5–10 (1873); *ibid.*, *Bul.*, pp. xvi, xx–xxii, lvi (1852); *Ann. Soc. Entom. Belg.*, vol. 12, pp. 1–10 (1868–1869).
Grinnell, Fordyce, *An early naturalist in California*, Entom. News, vol. 15, pp. 202–203 (1904).
Comstock, W. P., *Lycænidæ of California described by Boisduval*, Jour. N. Y. Entom. Soc., vol. 22, p. 33 (1914).
Lorquinia, vol. 1, p. 23 (1916); p. 92 (1917).
Wade, J. S., *Ann. Entom. Soc. Am.*, vol. 21, p. 507 (1928).
Horn, W., and Schenkling, S., *Index Litt. Entom.*, vol. 4, p. 1415 (1929).
[223] Grinnell, Fordyce, *op. cit.*, p. 202.

traversed much of the state in search of butterflies and moths. In 1852–1853 he collected in the gold fields at Downeyville, Sierra County, in Plumas and Eldorado counties, Carson City, Nevada, Sacramento and Stockton, as well as in Los Angeles and San Diego. From 1854–1856 he collected on the Yuba River in Sierra and in the counties of Plumas, Amador, Calaveras, Mariposa, Merced, Madera, Fresno, San Francisco, Marin, and Sonoma. While in the state he allied himself with other scientists and particularly with those of the California Academy of Sciences, where he met H. H. Behr in 1852 and became his close friend. His love of collecting took him to the Philippine Islands in 1856, and to China, and he did not return to California until 1860. After remaining one year in the state he left for Cochin China, in 1862 and visited and collected in China, the Philippine Islands, Celebes, Aru Islands, Ceram, Amboyna, Ternate, Gilolo, and Java. In the latter place he was attacked by a fever and when he recovered sufficiently he returned to Paris, France, in 1865. He then traveled through southern France and Spain and returned finally to Paris on July 2, 1870. He was planning to return to the Celebes with his grandson, Leon Laglaize, when he suddenly died on February 8, 1873. Prior to the coming of Lorquin very few butterflies had been collected in California. Of the species of California Lepidoptera described by

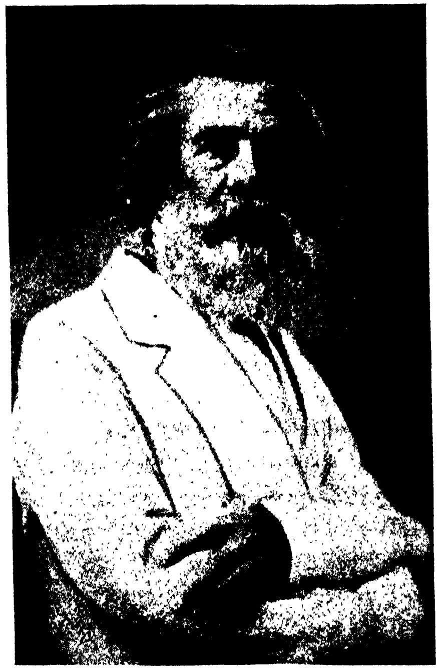

Fig. 215.—Pierre Joseph Michel Lorquin (1797–1873), a Frenchman, was the outstanding early entomological collector in California. He arrived during the gold excitement of 1850 and preferred to collect butterflies and moths to gold nuggets and thereby made an everlasting name for himself. (From an enlargement of an original photograph in the Los Angeles Museum through the kindness of Dr. John A. Comstock, October 11, 1927.)

Boisduval,[224] all except five or six which were supplied by E. Doubleday, were collected by Lorquin. Of the species which he took in California, Boisduval listed ninety-five, of which eighty-three were butterflies and twelve were moths. Fifty-three butterflies and nine moths were described as new species. One butterfly, Lorquin's admiral, *Basilarchia lorquini* (Boisduval), a most beautiful and interesting species occurring throughout much of the state and very abundant in the Yosemite Valley, is a splendid living memento to this early collector. In connection with his collections, it is worthy of note that he did not overlook many of the really abundant and prevailing species of his time. It should also be mentioned that practically all of the species taken by him are still to be found in abundance in most parts of the state, while a few such as the western swallowtail, the alfalfa caterpillar, the monarch butterfly, the mourning cloak, the painted lady, the west coast lady, the buckeye, and others are very abundant throughout the lowlands of the entire state and the alfalfa caterpillar has become a pest of first rank to alfalfa grown from Imperial Valley to the upper end of the Sacramento Valley.

A few Lepidoptera collected by Lorquin also went to H. H. Behr, A. Guenée, and to A. R. Grote and C. T. Robinson.

A cerambycid beetle, *Calloides lorquini* Buquet, bears his name. This beetle, together with many others, were also collected by Lorquin in California and sent to Boisduval who turned them over to Lucien Buquet.[225] A carabid beetle, *Bembidion lorquini* Chadoir, was also named for him. In addition to insects, Lorquin also collected birds and shells. According to his son, E. F. Lorquin, formerly of San Francisco, Lorquin was a man of medium size, strong constitution, and great enthusiasm. He had as much difficulty in learning to speak English as most of us have with French.

He was survived by one son, Ernest F. Lorquin, who was curator of zoölogy of the California Academy of Sciences in 1865, and died at Toulon, France, on September 18, 1909. A grandson, Henry F. Lorquin, is a taxidermist, at Soquel, California, and a grand-

[224] Boisduval, J. A., *Lépidoptères de la Californie*, Ann. Soc. Entom. France, vol. 21, pp. 275–324 (1852); *Ann. Entom. Soc. Belg.*, vol. 12, pp. 1–94 (1868–1869). (Butterflies and moths described.)

Bul. Entom., In Ann. Soc. Entom. France, pp. xxx–xxxii (1855). Descriptions of *Samia euryalus* (Bdv.). See silkworm, p. 231.

[225] *Ann. Soc. Entom. France* (3), pp. xx–xxii (1852); pp. 629–630 (1859).

daughter, Mrs. M. B. Templeton, lives in Hayward, California. The latter kindly furnished information relative to her father and brother.

His insect collections are incorporated with those of Boisduval in the Charles Oberthur collection at Rennes, France. Boisduval returned to Lorquin cotypes of each species when he described it. These were presented to the California Academy of Sciences through Behr and were destroyed with other collections in the fire of 1906.

Among the important Lepidoptera collected in California by Lorquin may be mentioned the following:

Eurymedon, *Papilio eurymedon* Bdv.
Pipevine swallowtail, *Papilio philenor* Linn.
Western parsley caterpillar, *Papilio zelicaon* Lucas.
Western swallowtail, *Papilio rutulus* Bdv.
California white, *Pieris sisymbri* Bdv.
Western orange tip, *Anthocharis sara* Bdv.
Alfalfa caterpillar, *Eurymus eurytheme* (Bdv.).
Monarch butterfly, *Danaus menippe* (Hübner).
Checker spot or Chalcedon, *Euphydryas chalcedona* (Dbldy. & Hew.).
California tortoise shell, *Aglais californica* (Bdv.).
Mourning cloak, *Aglais antiopa* (Linn.).
Red admiral, *Vanessa atalanta* (Linn.).
Painted lady or thistle butterfly, *Vanessa cardui* (Linn.).
Painted beauty or Hunter's butterfly, *Vanessa virginiensis* Drury.
West coast lady or malva butterfly, *Vanessa carye* (Hübner).
Buckeye, *Junonia cœnia* Hübner.
Lorquin's admiral, *Basilarchia lorquini* (Bdv.).
Arota, *Tharsalea arota* (Bdv.).
Knotweed butterfly, *Heodes helloides* (Bdv.).
Eyed blue, *Glaucopsyche xerces* (Bdv.).
Woodland skipper, *Ochlodes sylvanoides* (Bdv.).
Field skipper, *Atalopedes campestris* (Bdv.).
Brown day moth, *Pseudohazis eglanterina* (Bdv.).
California tussock moth, *Hemerocampa vetusta* (Bdv.).
Omnivorous looper, *Sabulodes caberata* Guenée.
Walnut looper, *Sabulodes forficaria* Guenée.
The strawberry crown moth, *Synanthedon bibionipennis* (Bdv.) [*Ægeria rutilans* (Hy. Edw.)].

The Lorquin Natural History Club, founded in 1913 and expired in 1919, and the Lorquin Entomological Society founded in 1917 and at present a thriving organization with over fifty members, bear the name of this early distinguished naturalist.

Mannerheim, Carl Gustav von [226] (Fig. 216). Born in 1804 and died in Stockholm, October 9, 1854. He was a very celebrated entomologist who worked up much of the material in the insect collections in the museums of Dorpat, St. Petersburg, and Moscow. In so doing he described a great number of beetles from Siberia, Alaska, and California, particularly many of those collected by J. F. Eschscholtz, F. Fischer, F. P. Wrangell, I. G. Vosnesensky, E. L. Blaschke, Tschernikh, H. J. Holmberg (Alaska), F. Frankenhæuser (Alaska), Fred Sahlberg (Alaska), and A. Pippingskold (Alaska).[227]

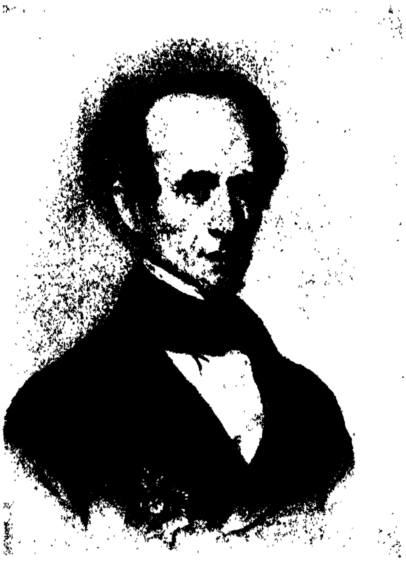

FIG. 216.—Carl Gustav von Mannerheim (1804–1854), governor of Finland, count, and noted coleopterist, who named many beetles taken in California by the early Russian entomological collectors. (Photograph furnished by Dr. L. O. Howard.)

Mannerheim was not only an entomologist and a voluminous writer, but was also a man of great ability along other lines. He was governor of Finland, president of the Kayserlichen Hofgerichtes of Wiburg, recipient of the Grand Cross of the Order of St. Stanislaus; Knight of the Order of St. Wladimir; and a member of many learned scientific societies, including the Entomological Society of France, 1833–1854.

[226] Swainson, W., *Bibliog. of Zoöl.*, p. 258 (1840).
Newman, E., *Proc. Entom. Soc. London*, vol. 3, n. s., p. 54 (1854).
Motschulsky, V. I., *Etudes Entom.*, vol. 4, pp. 1–7 (1855).
Nordmann, A. von, *Acta Soc. Finn.*, vol. 4, p. 24 (1855).
Hagen, H. A., *Bibliot. Entom.*, vol. 1, pp. 517–518 (1862).
Marseul, S. A. de, *L'Abeille*, vol. 24, pp. 170–173 (1886–1887).
Dow, R. P., *Bul. Brooklyn Entom. Soc.*, vol. 9, pp. 98–99 (1914).
Sahlberg, J. von, *Finska Tidskr* (Helsingfors), vol. 87, pp. 76–100 (1919).
Wade, J. S., *Ann. Entom. Soc. Am.*, vol. 21, p. 508 (1928).
Horn, W., and Schenkling, S., *Index Litt. Entom.*, vol. 3, pp. 786–788 (1928); vol. 4, p. 1416 (1929).

[227] F. W. Mäklin described a number of the specimens taken by Holmgren, Frankenhæuser, and Pippingskold in Alaska. His collection is in the Museum of the University of Helsingfors, Finland.

A few of the common important California beetles [228] named by Mannerheim are:

The bombardier beetle, *Brachinus tschernikhi* (Mann.).
Red net-winged beetle, *Eros simplicipes* (Mann.).
The punctured blister beetle, *Epicauta puncticollis* (Mann.).
The sugar beet wireworm, *Pheletes californicus* (Mann.).
The margined scymnid, *Scymnus marginicollis* Mann.
The striped ladybird beetle, *Ceratomegilla vittigera* (Mann.).
The California ladybird beetle, *Coccinella californica* Mann.
The gigantic eleodes, *Eleodes gigantea* Mann.
The grand eleodes, *Eleodes grandicollis* Mann.
Eleodes pimelioides Mann.
The pulverulent beetle, *Blapstinus pulverulentus* Mann.
Blaschke's beetle, *Cibdelis blaschkei* Mann.
The rugose stag beetle, *Sinodendron rugosum* Mann.
Opismus quadrilineatus Mann. (From Alaska.)
The Nautical borer, *Xylotrechus nauticus* (Mann.).
Disonycha maritima Mann.
The Western striped cucumber beetle, *Diabrotica trivittata* Mann. Mannerheim also listed *D. soror* Lec., collected in California by Eschscholtz and again by Tschernikh, as *D. duodecempunctata* (Fabr.).
Trirhabda flavolimbata (Mann.).
Golden tortoise beetle, *Metriona bicolor* (Fabr.). (*Coptocycla aurisplendens* Mann.).
The tule billbug, *Sphenophorus discolor* Mann..
Cleonus modestus (Mann.).
Sitka spruce dolurgus, *Dolurgus pumilus* (Mann.).
Sitka spruce beetle, *Dendroctonus obesus* (Mann.).
Shore pine beetle, *Pseudohylesinus sericeus* (Mann.).
Sitka spruce hylurgops, *Hylurgops rugipennis* (Mann.).
Red fir root borer, *Hylurgops nigrinus* (Mann.).
Lodgepole engraver beetle, *Ips concinnus* (Mann.).

His large collection is in the Zoölogical Museum of the University of Helsingfors, Finland.

Mannerheim wrote forty-two important papers on Coleoptera. The ones dealing with Alaska and California are:

Desc. de deux Coléoptères nouveaux de la Californie, Revue Zoölogique pour la Societé Cuvierienne, pp. 137–139 (1840). [Two species of beetles, *Eleodes fischeri* Mann. (Syn. of *E. marginata* Esch.) and *Coniontis eschscholtzi* Mann. collected by Fischer in California.]

Maximilian de Chaudoir (1816–1881), H. Dupont, and Ernst F. Germar (1786–1853), also described species taken by some of these collectors.

[228] In checking over the common species taken in California and Alaska the author finds that Eschscholtz collected ninety-two, Tschernikh fifty-four, Blaschke thirty-seven, Fischer eleven, Wrangell seven. Certain species were taken by more than one of these collectors.

Beitrag zur Käfer-Fauna der Aleutischen Insel, der Insel Sitka and Neu-Californiens, Bul. Nat. Hist. Moscow, vol. 16, pp. 175–314 (300 spp., 133 n. sp.) (1843), with 3 supplements in 1846, 1852, 1853. This work formed the basis for the study of the Coleoptera of the Pacific Coast. (Frederick W. Mäklin described the Staphylinidæ.)

Sur quelques espèces des Carabiques de Californie, Bul. Acad. St. Petersburg, vol. 4, pp. 105–108 (1845).

Nachtrag zur Käfer-Fauna der Aleutischen Insel und der Insel Sitka, Bul. Moscow, T. 19, P. 1, pp. 501–516 (1846).

Zweiter Nachtrag zur Käfer-Fauna der Nord Amerikanischen Lander des Russcihen Reiches, *ibid.*, T. 25, P. 1, pp. 283–387 (1852).

Dritter Nachtrag zur Käfer-Fauna der Nord-Amerikanischen Lander des Russichen Reiches, *ibid.*, T. 26, pp. 95–273 (1853).

Fig. 217.—George Marx (1838–1895), well-known entomological illustrator and one of the foremost American arachnologists. (After C. V. Riley et al., 1895.)

Marx, George [229] (Fig. 217). Born at Laubach, in Hesse, Germany, June 22, 1838; died in Washington, D. C., January 3, 1895. This most eminent American arachnologist and illustrator received his early education in Germany, completing his pharmaceutical studies at Giessen. His first work was the making of the illustrations for the Flora of Gross-Gerau. He came to America in 1860, and at the outbreak of the Civil War, enlisted as a private in Company K, 8th New York Volunteers and remained with his company until after the Battle of Bull Run, July 21, 1861, when he was transferred to the medical corps as assistant surgeon. Because of illness and a severe wound, he was honorably discharged in July, 1862, after which he returned to New York and became a

[229] Riley, C. V., et al., *Proc. Entom. Soc. Wash.*, vol. 3, pp. 195–201, portrait and example of drawings (1895).
Entom. News, vol. 6, p. 64 (1895).
Wade, J. S., *Ann. Entom. Soc. Am.*, vol. 21, p. 508 (1928).

pharmacist. In 1865 he moved to Philadelphia where he remained in business until 1878, when he accepted a position as natural history draftsman of the Division of Entomology, U. S. Department of Agriculture. In 1889 he was made chief of the newly created Division of Illustrations, which position he resigned shortly before his death. Soon after his arrival in Philadelphia he began the study of arachnids and later on became one of the greatest authorities in this field.

He kept close contacts with and assisted the distinguished European arachnologists, E. Keyserling, T. Thorell, and Eugene Simon, and the American arachnologists, H. C. McCook, J. H. Emerton, and G. W. and Elizabeth G. Peckham. On the death of Keyserling, Marx was selected to complete the work, Die Spinnen Amerikas,[230] of that competent authority.

He published many papers on spiders and three years before his death began the study of ticks, which interest he pursued most diligently to the last.

Marx is probably best known for the excellency of the numerous illustrations made by him during his early career as illustrator for the Bureau of Entomology. The celebrated plate of the catalpa sphinx,[231] as well as the many drawings of Coccidæ [232] prepared for J. H. Comstock, are familiar to all. His drawing, also, of the brown mite, almond mite, or clover mite, has been used by nearly every entomologist in America who wished a figure of this pest. A sample of his art in drawing ticks appears in plate ix in Nathan Banks' A Revision of the Ixodoidea, or Ticks, of the United States.[233]

Innumerable other drawings appeared in his own works and those of the different members of the Bureau of Entomology. Many, such as those of the cotton worm, boll worm, army worm, etc.,[234] were appropriated by C. V. Riley.

In all he published thirty-one papers chiefly in Insect Life, Proceedings of the U. S. National Museum, Proceedings of the Entomological Society of Washington, Entomologica Americana, and a few other periodicals. His most important papers are:

[230] *Die Spinnen Amerikas.* Brasilianische Spinnen [Nürnberg, 1891, Bauer and Raspe (Emil Kuster)].
Epeiridæ, ibid. (1892).
[231] *Rept. Dept. of Agriculture,* plate xiii (1881–1882).
[232] *Rept. Dept. of Agriculture,* 1880 (1881).
[233] U. S. Dept. Agr., Bur. Entom., *Tech. Ser. No. 15* (1908).
[234] Walton, W. R., *Proc. Entom. Soc. Wash.,* vol. 23, p. 93 (1921).

On the morphology of Scorpionidæ, Proc. Entom. Soc. Wash., vol. 1, pp. 108–112, 3 figs. (1888).

Catalogue of the described Araneæ of temperate North America, Proc. U. S. Nat. Mus., vol. 12, pp. 497–594 (1889–May, 1890).

On the effect of the poison of Latrodectus mactans *Walck. upon warm-blooded animals.* Proc. Entom. Soc. Wash., vol. 2, pp. 85–86 (1891).

On the morphology of the ticks, ibid., vol. 2, pp. 271–287 (1892).

Some Western spiders named by Marx are:

Usofila gracilis Marx.
Lutica maculata Marx (also named genus).
Homalonychus selenopoides Marx (also named genus).
Lycosa pudens Marx.

Marx also described a few Eastern species, but was greatly excelled in the technical field by N. M. Hentz, J. H. Emerton, E. Keyserling, G. W. and E. G. Peckham, and Nathan Banks.

While in Philadelphia, Marx obtained the medical degree M. D. at Columbia in 1885. He was a charter member of the Entomological Society of Washington in 1884 and the fourth president in 1891.

His collection contains 175 genera and more than 1,000 species of Araneæ. Five hundred of these are North American and include 30 of Marx's types and 30 types of Keyserling. Of the other five hundred, 200 are European and 300 are American which bear the manuscript names of Marx. The specimens are preserved in Müller's Fluid and are in vials in special trays of his own invention.[235] The spiders and ticks are in the U. S. National Museum. The Scorpionida, Solpugida, Pseudoscorpionida, and Pedipalpi were offered for sale at the death of Marx for fifteen hundred dollars.[236]

Maskell, William Miles[237] (Fig. 218). Born in Hampshire, England, in 1840; died at Wellington, New Zealand, May 1, 1898. He was educated at the Catholic College of St. Mary, Oscott, near Birmingham, England, and in Paris. He afterwards served three years in the English army and "went out to New Zealand in 1860

[235] Riley, C. V., U. S. Nat. Mus., *Bul. 39*, pt. F (1893).

[236] *Entom. News*, vol. 6, p. 265 (1895).

[237] *Entomologist*, vol. 31, p. 176 (1898).

New Zealand Inst., Trans., vol. 31, pp. 708–709 (1898).

Trimen, R., *Trans. Entom. Soc. London* (*Proc.*), pp. liv–lv (1899). Separately, pp. 6–7 (1899).

Alpers, O. T. J., *The Jubilee Book of Canterbury Rhymes* (Christchurch, N. Z., Whitcombe and Tombs, Dec., 1900), 176 pp.

Wade, J. S., *Ann. Entom. Soc. Am.*, vol. 21, p. 508 (1928).

in the ship *William Miles*, and landed at Lyttleton the same year. In Canterbury he worked for some time on sheep stations until, having gained sufficient experience, he took up a sheep run on his own account in Kaikoura in the Marlborough district. In 1864 he returned to Canterbury; and for the eight years following he was farming at Sefton. He was elected a member of the Privy Council in 1865 and kept his seat until 1875, when the General Assembly took over the reins of the government. In 1874 he was appointed Provincial Secretary and Treasurer of Canterbury. . . . Maskell was appointed in succession to E. Jolly, who at that time represented Selwyn. On the formation of the New Zealand University he was appointed Registrar and during the time that J. Tancred held the position of Chancellor he resided in Christchurch; but when James Hector assumed the Chancellorship Maskell went to Wellington, where he has lived ever since. Maskell was a widely read man, who took keen interest in scientific matters. He was a prominent member of the Philosophical Institute both in Christchurch and Wellington, and in fact assisted in the foundation of the Institute. As a rimester he was a worthy successor to Crosbie Ward, and older Christchurch residents will remember many of his witty verses—chiefly satires on the politics and politicians of the day—contributed to the Christchurch Press in the '70's and early '80's. He was well known as an entomologist; and some of his papers on Coccidæ, of which family he was recognized an authority, were widely published."

FIG. 218.—William Miles Maskell (1840–1898), one of the leading coccidologists of the world, described many of the important injurious scale insects which have been introduced into America. (Photograph furnished by E. T. Norris, Registrar, University of New Zealand, 1929.)

Maskell was the pioneer coccidologist of New Zealand, Australia, and the neighboring islands. He described a very large number of

species of scale insects, many of which have since become of great economic importance to agriculture throughout the world whither they have been transported. His most important papers were published in the Transactions of the New Zealand Institute, Wellington.[238] He also published an important treatise, An Account of New Zealand Scale Insects, Wellington, 116 pp., 23 col. pls. (1887).

His collection of Coccidæ was a large one because of the many specimens he received from all parts of the world for identification. It consisted of over a thousand named species, many hundreds of mounted slides and 750 unmounted species. In addition, he also collected Psyllidæ and Aleyrodidæ. His collections are in charge of the New Zealand Government at Wellington.

Some of the important economic coccids, described by Maskell and which have been introduced and established in California are the following:

Cottony cushion or fluted scale, *Icerya purchasi* Maskell.
Araucaria scale, *Eriococcus araucariæ* Maskell.
Golden mealybug, *Pseudococcus aurilanatus* (Maskell).
Palm mealybug, *Pseudococcus nipæ* Maskell.
Red scale, *Chrysomphalus aurantii* (Maskell).
Black araucaria scale, *Chrysomphalus rossi* (Maskell).

McGlashan, Charles Fayette. Born near Jamesville, Wisconsin, August 12, 1847; at present living at Truckee, California. He crossed the plains in an ox wagon and arrived in California in September, 1854, and later attended the Sotoyome Institute at Healsburg, 1862–1865, and Williston Seminary, Easthampton, Massachusetts, 1868–1870. When he was principal of the Placerville high school in 1871–1872, he took a class four miles to Negro Hill to look through a telescope owned by a Mr. Oldfield,[239] an Englishman and a miner and an ardent entomological collector. A large number of moths emerged that day and after being instructed in the art of collecting and rearing moths and butterflies, McGlashan became fired with entomological enthusiasm which has never ceased. After he became principal of the Truckee schools,

[238] Vol. 11, pp. 187–228 (1879); vol. 16, pp. 120–144 (1884); vol. 17, pp. 20–31 (1885); vol. 19, pp. 41–45, 46–49 (1887); vol. 22, pp. 133–156 (1890); vol. 23, pp. 1–36 (1891); vol. 24, pp. 1–64 (1892); vol. 25, pp. 201–252 (1893); vol. 26, pp. 65–105 (1894); vol. 27, pp. 1–35, 36–75 (1895); vol. 28, pp. 380–411 (1896); vol. 29, pp. 293–331 (1897); vol. 30, pp. 219–252 (1898).

[239] The Oldfield collection of Lepidoptera was presented to the California Academy of Sciences and destroyed by the earthquake and fire of April, 1906.

July 12, 1872, he devoted much of his time to collecting, rearing, and distributing Lepidoptera. His work attracted attention of many entomologists. Henry Edwards visited him and taught him how to sugar for moths and during the twelve years from 1875–1887, McGlashan sent him the most of the moths reared and collected, so that many specimens in the Edwards' Collection, now at the American Museum of Natural History, New York, bear the locality "Truckee." During the years 1884–1887 he also collected eggs, larvæ, and pupæ of butterflies for W. H. Edwards, who gave him much information as to securing eggs and rearing the caterpillars of butterflies. In turn Edwards determined all of the butterflies in his collection. Albert Kœbele collected with McGlashan at Truckee in 1886. During the early eighties specimens were collected for B. Neumogen, Gamble Geddes, Herman Strecker, W. G. Wright, James Behrens, J. J. Rivers, and others. As a result of his endeavors he amassed a collection of 20,000 specimens, especially rich in butterflies. Many specimens were preserved in patented, wholly glass cases, each of which is described as follows:

> The case is made wholly of glass, preferably in the form of a six-sided box. It is made in sections, each side being a separate piece—that is to say, the top is one piece of glass, its bottom another piece of glass, and each of its sides one piece of glass. The meeting edges of each piece are beveled or chamfered to an angle to suit the particular case, and these joints are thoroughly cemented together, so that the sections of the case become practically a single piece, forming a hollow shell or casing which is permanently and hermetically sealed.

The specimens are pinned to a strip of cork cemented to the glass.[240]

Beginning in 1912 and continuing until the World War in 1915, he taught his daughter, Ximena McGlashan,[241] how to collect and rear butterflies and moths, how to sugar moths and the methods of disposing of the adults. A butterfly farm was established at Truckee, a correspondence course for amateur entomologists given to hundreds of pupils, and a monthly magazine [242] issued.

His collections are still maintained at his home in Truckee.

For him Rivers named *Lemonias macglashani* which proves to be a form of *Euphydryas chalcedona* (Dbldy. & Hew.), and Henry Edwards named *Hepialus macglashani*, a synonym of *H. pulcher* Grote.

240 *Pacific Rural Press*, vol. 35, p. 378 (Apr. 28, 1888).

241 Now Mrs. J. C. Howard.

242 *The Butterfly Farmer*, vol. 1, no. 1 (September, 1913) to vol. 1, no. 12 (August, 1914), 208 pp.

Ménétriés, Edouard [243] (Fig. 219). Born at Paris, October 2, 1802; died at St. Petersburg, April 10, 1861. Conserver of rarities at the Zoölogical Museum in the Imperial Academy of Sciences, St. Petersburg. He was an authority on Lepidoptera and Coleoptera and worked in other orders as well, and named species from many parts of the world, but of his 28 papers most of them had to do with insects taken in Russia and Siberia. At the Museum in St. Petersburg he had an opportunity to study the extensive collections of insects made in Siberia, Alaska, and northern California by the expeditions of P. Middendorff (1842–1845) and L. Schrenck (1853–1857) as well as those taken by the individual collectors I. G. Vosnesensky, K. Maximowicz, D. Wulfius, H. Christoph, F. Derbek, M. Yankovski, A. Rimski-Korsakov, and others. His California Coleoptera were largely described in a paper entitled: Sur un envoi d'insects de la côte N. O. d'Amérique, Bul. Acad. St. Petersburg, T. 2, pp. 49–64 (1844); Isis, vol. 5, p. 368 (1846); and the Lepidoptera in Enumeratio coporum animalium musei impearialis Academie scientiarum Petropolitaniæ, Petropoli (St. Petersburg), vol. I (1855) to vol. III (1863). (The last part published by F. Morawitz.)

Fig. 219.—Edouard Ménétriés (1802–1861) the leading Russian Entomologist of his time at the Imperial Academy of Sciences, St. Petersburg. He described many of the insects collected in Siberia, Alaska, and California by the early Russian entomologists. (Photograph from the G. Kraatz collection through the courtesy of Dr. Walther Horn.)

Ménétriés described Coleoptera taken by Vosnesensky in California. Some of the important species are:

[243] Hagen, H. A., *Biblio. Entom.*, vol. 1, pp. 531–532 (1862) (Bibliography).
Horæ, Soc. Entom. Ross., vol. 2, pp. 1–7, portrait (1863).
Marseul, S. A. de, *L'Abeille*, vol. 22, pp. 137–139 (1884) (Bibliography).
Schmidt, P., *Pacific Russian scientific investigations*, Acad. Sci., U. S. S. R., pp. 140, 152, 153, 154 (1926).
Horn, W., and Schenkling, S., *Index, Litt. Entom.*, vol. 3, pp. 810–812 (1928).
Also see sketch of I. G. Vosnesensky, pp. 777–788.

Polycesta californica Mén. Ross.
Chrysobothris subcylindrica Mén. New Helvetia. (Sacramento.)
Monocrepidius hirsutulus Mén. Ross.
Limonius infuscatus Mén. New Helvetia.
Limonius maculicollis Mén. San Francisco.
Scaphinotus interruptus Mén. Ross.
Nebria eschscholtzi Mén. California, Alaska.
Ctenucha rubroscapus Mén. As this is a Sierran species I do not know how it got into his hands, unless perchance Vosnesensky secured it from some collector at New Helvetia. (Sacramento.)
Parnassius clodius Mén. Mts. Pacific States.
Parnassius eversmanni Mén. Alaska, Siberia.

His collection is in the Museum of the Academy of Leningrad (St. Petersburg).

FIG. 220.—Robert M'Lachlan (1837–1904), the great British entomologist, described many of the neuropterous insects of this country. (After P. P. Calvert, 1904.)

M'Lachlan, Robert [244] (Fig. 220). Born near Ongar in Essex, England, April 10, 1837; died at Lewisham, London, May 23, 1904, in his sixty-seventh year. Leading English neuropterist. He was educated chiefly at Ilford and inherited sufficient means to devote all of his time to the study of natural history and travel. First taking up botany, he later became interested in entomology and finally specialized in the Neuroptera in its larger phases. He was a careful and thorough scientist and his work is of the first order. He was always interested in the broad field of his subject and was the first editor of the Entomologists' Monthly Magazine, and

[244] Hagen, H. A., *Bibliot. Entom.*, vol. 1, p. 510 (1862).
Autobiography, *Proc. Entom. Soc. London*, pp. lxxxi–lxxxiii (1886).
Eaton, A. E., and Saunders, E., *In Memoriam*, Entom. Mthly. Mag., vol. 40 (2): vol. 15, pp. 145–148 (1904).
Saunders, E., *Entom. Mthly. Mag.*, vol. 40, pp. 145–148 (1904).
Lucas, W. J., *Entom.*, vol. 37, pp. 195–196 (1904).
Poulton, E. B., *Trans. Entom. Soc. London*, Proc., p. xxxviii, xcvi–xcviii (1904).
Calvert, P. P., *Entom. News*, vol. 15, pp. 226–228, portrait, pl. xvi (1904).
Entom., vol. 37, pp. 195–196 (1904).
Entom. Record, vol. 16, p. 217 (1904).
Ann. Soc. Nat. Hist., no. 52, pp. 201–203 (Oct., 1904).
Nature, vol. 70, p. 106 (1904).

served for many years, and a contributor to many serial publications. He was elected a member of the Entomological Society of London in 1858, secretary 1868–1872, treasurer 1873–1875, 1891–1904, president 1885–1886; fellow of the Linnean Society 1862–1904; Royal Society 1877–1904; Zoölogical Society 1881–1904; Royal Horticultural Society 1888–1904; member of the Council of the Ray Society; and honorary member of many home and foreign societies.

His most important general works are:

Monograph of the British species of caddis-flies, Trans. Entom. Soc., London (3), vol. 5, pp. 1–184, pls. i–xiv (1865).

Monograph of the British Neuroptera-Planipennia, *ibid.*, pp. 145–224, pls. viii–xi (1868).

Monograph British Psocidæ, Entom. Mthly. Mag., vol. 3, pp. 177–181, 194–197, 226–231, 241–245, 270–276, pl. 2 (1866–1867).

Catalogue of British Neuroptera, Entom. Soc. London (1870).

Monographic revision and synopsis of the Trichoptera of the European fauna (London, John Van Voorst, 1874–1880), 523+103 pp., 59 pls. (published in nine parts and considered his greatest work).

M'Lachlan named a great many American insects, of which some of interest are:

Archilestes californica M'Lachlan.
Gomphoides obscura borealis (M'Lachlan).
Anax walsinghami M'Lachlan (the largest dragonfly in North America).
Macromia magnifica M'Lachlan.
Tetragoneuria canis M'Lachlan.
Sympherobius perparvus (M'Lachlan).
Oregon panorpid, *Panorpodes oregonensis* M'Lachlan.
Wingless scorpion fly, *Bittacus apterus* M'Lachlan.
Green stigma, *Bittacus chlorostigma* M'Lachlan.
Agapetus celatus M'Lachlan.
Notidobia griseola M'Lachlan.
nigricula M'Lachlan.
Heteroplectron californicum M'Lachlan.
Tinodes consueta M'Lachlan.

His collection of Neuroptera became the most important in the British Isles. It is at present in charge of his nephew at Lewisham.

Trans. Entom. Soc. London, pp. 367–370, Proc., p. lxxv (1905).
Navas, R. P. L., *Bul. Inst. Catalana*, vol. 2, pp. 44–47, portrait (1905).
Wade, J. S., *Ann. Entom. Soc. Am.*, vol. 21, p. 508 (1928).
Horn, W., and Schenkling, S., *Index Litt. Entom.*, vol. 3, pp. 775–776 (1928); vol. 4, p. 1415 (1929).
Also spelled McLachlan and MacLachlan.

Morrison, Herbert Knowles [245] (Fig. 221). Born at Boston, Massachusetts, January 24, 1854; died at Morgantown, North Carolina, June 15, 1885. One of the charter members of the Cambridge Entomological Club and an insect collector of note. He published largely during the years 1873–1875, chiefly in the Proceedings of the Boston Society of Natural History, of which organization he was also a member. "In 1876, he visited the southern United States expressly to explore the field which John Abbot [246] had made famous. His captures there were doubly successful, for he found occasion to return there the next year to be married, and made his home there (Morgantown, Georgia) ever after. In 1874 he collected insects in Colorado, in 1878 in Nevada (Utah, and the Black Hills), in 1879 in Washington territory, near the close of the season losing his entire collection and outfit by fire, in 1880 in Arizona and southern California, in 1882 in (Arizona [247] and) New Mexico, in 1883 in Florida, in 1884 near Key West, Florida, and later in Nevada, in the spring of 1885 at Key West where he had an attack of dysentery which proved fatal. He was a very muscular man, and endowed with wonderful powers of endurance, which he

FIG. 221.—Herbert Knowles Morrison (1854–1885), one of the greatest American entomological explorers and collectors. He also described a number of important noctuid moths. (Photograph furnished by Dr. L. O. Howard.)

[245] *Entomologica Americana*, vol. 1, p. 100 (1885).
Mann, B. P., *Psyche*, vol. 4, p. 287 (1885).
Wade, J. S., *Ann. Entom. Soc. Am.*, vol. 21, p. 510 (1928).

[246] Pioneer lepidopterist of Georgia and excellent delineator of all stages of butterflies and moths.

[247] Edwards, W. H., *Notes on the collection of butterflies made by Mr. H. K. Morrison, in Arizona*, 1882, Papilio, vol. 2, pp. 136–143 (1882); vol. 3, pp. 1–10 (1883). The list includes 103 species and varieties and embraces most of the common species occurring in the Southwest.

taxed to the utmost." As a professional collector he had a splendid reputation for care and reliability and furnished specimens of insects, but chiefly Lepidoptera for systematists both in America and Europe. He named a number of species from the Western region including the noctuid moths, *Oncocnemis meadiana* Morrison, *Rhynchagrotis rufipectus* (Morrison), *R. exsertistigma* (Morrison), and the pale Western cutworm, *Porosagrotis orthogonia* Morrison. Species of Lepidoptera were named for him by Henry Edwards, E. L. Ragonot, W. H. Edwards, Lord Walsingham, H. Druce, A. R. Grote, M. Jacoby, E. T. Cresson, and C. V. Riley. The Coleoptera collected by him were mostly described by George H. Horn.

The following are some of the insects bearing his name:

Ophiogomphus morrisoni Selys.
Anæa morrisoni Edwards.
Pamphila morrisoni (Edwards).
Morrisonia Grote (Genus).
Stamnodes morrisata (Hulst).
Heterographis morrisonella Ragonot.
Eucosma morrisoni Wlshm.
Luperodes morrisoni Jac.
Morrison's horntail, *Xeris morrisoni* (Cress.).

Morse, Albert Pitts (Fig. 222). Born at Sherborn, Massachusetts, February 10, 1863; at present curator of Natural History, Peabody Museum, Salem, Massachusetts.

Morse is an authority on Orthoptera and was intimately associated with S. H. Scudder at Cambridge, Mass. At Wellesley he has been curator of the zoölogical museum since 1890 and lecturer on economic entomology as long as the subject was taught; instructor of zoölogy and entomology in Teachers' School of Science, Boston, 1901–1910; research assistant of the Carnegie Institution, 1903 and 1905; curator of natural history, Peabody Museum, Salem, Mass., since 1912; three times president of the Cambridge Entomological Club; and twice president of the Morse Science Club of Salem. While his first specialty was ornithology, he early began the study of Orthoptera and especially the Acridiidæ of North America, collected extensively in New England, the Southern States, and California. He later became an authority on New England entomology and also described Odonata.[248] Most of his sixty papers on North American Orthoptera were published

[248] *New North American Odonata*, Psyche, vol. 7, pp. 207–211, 274–275, 307 (1895).

in Psyche.[249] He also published other important papers on this order,[250] including a monograph of the New England species.[251]

At the suggestion of Scudder he made an extensive collecting trip to California during the summer of 1897 and gave a most interesting account of the country, the conditions, expenses, and other matters of that time.[252] Among other things he states that with strict economy a three months' round trip from Boston to California could be made for four hundred dollars, that the meals en route on the dining cars averaged seventy-five cents each, rates at railroad hotels from two to four dollars a day, hotels in towns from a dollar to a dollar and a quarter a day, and in "Los Angeles and San Francisco meals may be had for 'two bits' (25 cents). . . ."[253] He also discussed baggage, weather, temperature, clothing, camping, canteen, col-

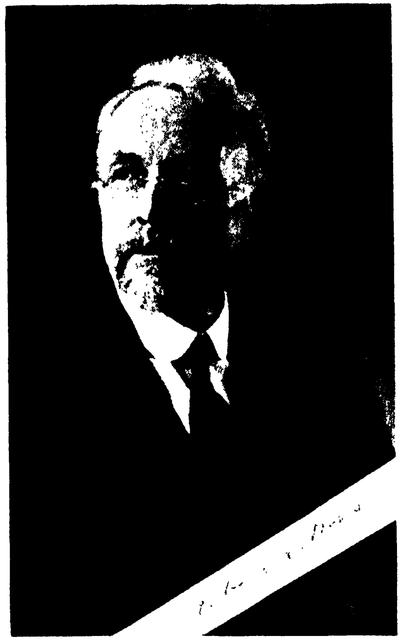

FIG. 222.—Albert Pitts Morse (1863–), eminent American orthopterist, who collected insects in California in 1897 and wrote a splendid account of the entomological conditions in the state at that time. (Photograph received in 1928.)

[249] *Notes on the Acridiidæ of New England, I, Tettiginæ*, Psyche, vol. 7, pp. 147–154, 163–167, pl. 6 (1894); *II, Tryxalinæ*, pp. 323–327, 342–344, 382–384, 402–403, 407–411, 419–422, 443–445, pl. 7 (1896–1897); *III, Œdipodinæ*, vol. 8, pp. 6–8, 35–37, 50–51, 64–66, 80–82, 87–89, 91–114, pl. (1897); *IV, Acridiidæ*, pp. 247–248, 255–260, 269–273, 279–282, 292–296, pl. 7 (1898).

[250] *Tettiginæ*, Biol. Cent. Am., Orth., vol. 2, pp. 3–19, 16 figs. (1900).

Researches on North American Acridiidæ, Carnegie Inst. Wash., Pub. 18, 55 pp., 10 pls. (1904). (This paper contains the first classification of Acridian habitats and much material of ecological interest); Pub. 68, 54 pp., 10 pls. (1907).

[251] *Manual of the Orthoptera of New England*, Boston Soc. Nat. Hist., Proc., vol. 35, no. 6, pp. 197–556, 99 figs., pls. 10–29 (1920).

[252] *Psyche*, vol. 8, pp. 160–167, 174–177 (1898).

[253] In commenting on this in March, 1928, Morse has added the following note: "As a matter of fact, I bought many meals in Los Angeles, San Francisco, and Portland at Chinese and Japanese restaurants for 10 or 15 cents each,—square meals they were, too, with no frills. The 'two bit' price was current at American-run restaurants and I had my choice of coffee, tea, or Zinfandel wine."

lecting apparatus, preservation of material, collecting season for Orthoptera, observations on other orders, character of collecting, precautions, drying out material, poisonous animals and plants, preparations, and then gives a list of the points visited which included Yuma, Arizona, Indio, Palm Springs, San Bernardino, Los Angeles, San Diego, Lancaster, Mohave, Tehachapi, Bakersfield, Tulare, Raymond, along the route and in Yosemite Valley, San Francisco, Sacramento, Tehama, Sisson, tree-line and summit of Mt. Shasta, Gazelle, Klamath, Siskiyou, in California, and thence along the way to Tacoma, Wash. In California he collected in many of the old type localities of earlier entomologists and his visit indicates how year after year many of these same localities are visited and worked over. The material thus collected was largely turned over to S. H. Scudder for naming, but Morse worked up the Xiphidiini and Tettiginæ.[254]

The following damselflies (Odonata), occurring in California and other Western states were named by Morse:

Enallagma calverti Morse.
carunculatum Morse.
clausum Morse.

Morse later became one of the leading entomologists of the New England States, and is interested in many of the natural history activities of Massachusetts.

The genus *Morsea* [255] of southern California has been named for him by Scudder. W. S. Blatchley also named the Indiana species, *Melanoplus morsei* for him and W. M. Wheeler named an ant, *Formica morsei* (Massachusetts), and T. D. A. Cockerell, a bee, *Centris morsei* (New Mexico and Texas), for him from specimens of his collecting.

Motschulsky, Victor Ivanovich [256] (Fig. 223). Born in 1810; died at Simferopol, Crimea, Russia, June 5, 1871. One of the most

[254] *Psyche*, vol. 18, p. 192 (1911).
[255] Morsea californica *Scudder* (*Orthoptera*), Psyche, vol. 8, p. 179 (1898).
[256] Hagen, H. A., *Bibliot. Entom.*, vol. 1, pp. 550–553 (1862) (Bibliography).
Marseul, S. A. de, *L'Abeille*, Les Entomologistes et leurs écrits, vol. 24, pp. 164–170 (1886–1887) (Bibliography).
Brokhaus, F. A., and Efron, J. A., *Russian Encyclop.*, vol. 20, book 39 (St. Petersburg, 1897).
Newman, Edw., *Entom.*, vol. 6, p. 56 (1872).
Becker, A., and Schaufuss, C., *Ins. Börse*, vol. 22, pp. 4, 14 (1905).
Schmidt, P., *Pacific Russian scientific investigations*, Acad. Sci., U. S. S. R., pp. 152, 153, 154 (1926).
Horn, Walther, *Entom. Mitteilungen*, vol. 16, pp. 1–9, 93–98 (1927).
Horn, W., and Schenkling, S., *Index Litt. Entom.*, vol. 3, pp. 841–846 (1928) (Bibliography).

famous of the Russian entomologists and a name familiar to students of insects in California and the world over. Although he has been severely criticized and even condemned by many of the coleopterists for carelessness, nevertheless he did a monumental work under most difficult circumstances and his worth is becoming more appreciated as it is better known. In fact some of the modern workers place him well up in the ranks of the coleopterists of the world. He studied and described many of the beetles taken in Siberia, Alaska, and northern California by the various Russian scientific expeditions, notably that under L. Schrenck (1853–1857), as well as those procured by the collectors, I. G. Vosnesensky, K. Maximowicz, D. Wulfius, H. Christoph, A. Cherski, F. Derbek, M. Yankovski, A. Rimski-Korsakov, D. Ivanov, N. Palchevski, L. Grinevetski, G. Suvorov, M. Berger, M. Dukin, Shingare, Christinich, Basnin, and others.

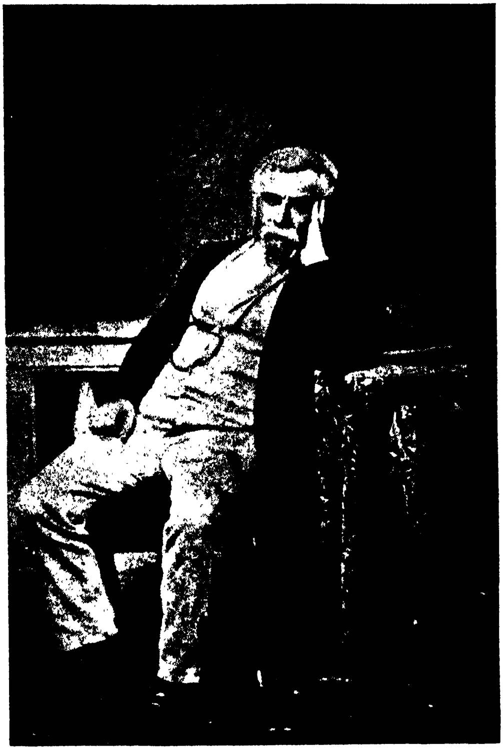

FIG. 223.—Victor Ivanovich Motschulsky (1810–1871) was one of the greatest Russian entomologists. He collected very extensively in the old world and described an enormous number of species from many parts of the world, especially from the vast Russian possessions of Siberia, Alaska, and also from California. (From a photograph taken July 28, 1862, and furnished by Dr. Walther Horn.)

As a military officer, having finally attained the rank of colonel, he had an unusual opportunity for travel and he made the most of it. In addition to many small trips he made five great journeys on which he assiduously collected and studied insects, chiefly Coleop-

tera. These trips were as follows: (1) In 1836 throughout Germany, France, Switzerland, the Alps, northern Italy and Austria and returned with 4,000 specimens of insects. In 1838 he made a short trip into the Caucasus. (2) In 1839–1840 through the Russian Caucasus, Astrakhan, Kazan, and Siberia as far as Irkutsk on Lake Baikal. In 1847 he collected on the Kirghiz Steppes and in 1849 he was in St. Petersburg. (3) In 1850–1851 he visited many of the principal cities in Germany, Austria, touched Egypt, India, France, England, Belgium, Holland, Austria (Dalmatia), and St. Petersburg. (4) In 1853 he made a trip to the United States where he visited New York, Niagara Falls, Cincinnati, Mammoth Cave and returning to New York sailed for Panama and thence to New Orleans, where he was afflicted with yellow fever for seven weeks, Georgia, Washington, Philadelphia, Boston and back via Hamburg, Kiel, Copenhagen, and St. Petersburg. (5) In 1855 through Germany, Switzerland, Austria, and Poland.

In addition to the vast amount of material collected by him he had an opportunity to work up the enormous amounts of insect material collected in Siberia by the many Russian scientists taken on the expeditions made by L. Schrenck, 1859–1867 in the Amur and Ussuri districts,—I. G. Vosnesensky in Siberia, Kamchatka, Alaska, and northern California and by a great many other collectors, too numerous to mention here.[257] He described chiefly Coleoptera, but he also worked somewhat in other orders. His studies included practically every phase of entomology such as systematic, biologic, ecologic, faunistic, statistic, cultural, regional, phytogenetic, historic, technical, and bibliographic. Of his 45 published works the following are the most important in this study:

Insectes de la Sibériæ rapportés d'un voyage fait en 1839–40, Mém. Acad. St. Petersbourg, vol. 13, 274 pp., 10 col. pl. (1845). Reprinted in *L'Abeille*, vol. 16, pp. 52–164 (1878); vol. 18, pp. 51–152 (1881). (Contains descriptions of *Prionus californicus* Mots., p. 89 and *Rosalia funebris* Mots., p. 87.)

Die coleopterologischen Verhältnisse und die Käfer Russlands, 1. c. 2, 131 pp., 1 chart, Bul. Moscow, T. 18, no. 3, pp. 1–131 (1845). Also separate (Moscow, Gautier, 1846). (Gives brief account of a number of early collectors and entomologists who collected in Russian-North America or who described insects taken there.)

Etudes Entomologiques, Helsingfors, 11 vols., 1852–1862. [Contains original description of *Scutellista cyanea* Mots. in vol. 8, pp. 171–172 (1859).]

[257] See the *Pacific Russian scientific investigations*, Acad. Sci., U. S. S. R., pp. 152–154 (1926).

Nécrologue de Fischer de Waldheim et Mannerheim, Etud. Entom., vol. 4, pp. 1–7 (1855).

On the means of destroying the grasshopper. Translated in Smiths. Inst., Ann. Rept., 1858, pp. 214–228 (1859).

Coléoptères nouveaux de la Californie, Bul. Moscou, vol. 32, pp. 122–185, 357–410, 2 pls. (1859, 1860). (Descriptions of species collected in California by Vosnesensky at Fort Ross, San Francisco Bay region, and New Helvetia.)

Among the interesting Western insects named by him may be mentioned:

Bembidion breve (Mots.).
bifasciatum Mots.
erosum Mots.
subinflatum Mots.
Trachypachus inermis Mots.
Brennus crenatus (Mots.).
Platidius californicus (Mots.).
Pterostichus ménétriési Mots.
Lebia bilineata Mots.
Yellow-bellied carrion beetle, *Necrophorus guttula* Mots.
Podabrus latimanus (Mots.).
Cantharis transmarinus Mots.
The bright net-winged beetle, *Eros lætus* (Mots.).
Limonius infuscatus Mots.
maculicollis Mots.
Athous nigripili Mots.
Cardiophorus amplicollis Mots.
The California prionus, *Prionus californicus* Mots.
The laurel borer, *Rosalia funebris* Mots.
Most of the above were collected by Vosnesensky.

An introduced insect of importance in California named by Motschulsky is the scutellista, *Scutellista cyanea* Mots.,[258] which was introduced into southern California from South Africa in 1902 to prey upon the black scale, *Saissetia oleæ* (Bernard).

His large collection is in the possession of the Society of Natural History of Moscow in the Imperial Museum of Moscow, with duplicates in the Museum at Leningrad.

Mulsant, Etienne[259] (Fig. 224). Born at Mornand (Rhône), France, March 2, 1797; died at Lyons, November 4, 1880. He was

[258] This insect was described from Ceylon where it was reared from *Saissetia hemisphærica* (Targ.), *Etud. Entom.*, vol. III, p. 172, T. 1, fig. 17 (1859).

[259] Hagen, H. A., *Bibliot. Entom.*, vol. 1, pp. 558–563 (1862).

Félissis-Rollin, J., *Ann. Soc. Entom. France* (5), vol. 10, pp. 403–413, portrait (1880).

Naturaliste, vol. 2, no. 40, p. 319 (1880).

professor of natural history at the Lyceum and librarian at Lyons and a scholarly French coleopterist, the pioneer and one of the greatest world authorities of the *Coccinellidæ.* His name is very

FIG. 224.—Etienne Mulsant (1797–1880), French entomologist and world authority on the ladybird beetles, family Coccinellidæ. He named many of our common native and introduced species. (After J. Féllisis-Rollin, 1880.)

familiar to all California entomologists because of the important native and introduced ladybird beetles named by him. A few of these are:

The lateral ladybird beetle, *Hyperaspis lateralis* Muls.
* The mealybug destroyer, *Cryptolæmus montrousieri* Muls.
* The vedalia, *Rodolia cardinalis* (Muls.).
The spotted ladybird beetle, *Ceratomegilla fuscilabris* (Muls.).
LeConte's ladybird beetle, *Hippodamia lecontei* Muls.
The two-stabbed ladybird beetle, *Chilocorus bivulnerus* Muls.
The Mexican bean beetle, *Epilachna corrupta* Muls.

Westwood, J. O., *Entom. Mthly. Mag.*, vol. 17, pp. 189–190 (1880–1881).
Fitch, E. A., *Entomologist*, vol. 14, pp. 46–47 (1881).
Kraatz, G., *Deutsche Ent. Zeit.*, vol. 25, pp. 337–338 (1881).
Katter, F., *Entom. Nachr.*, vol. 7, p. 36 (1881).
Zoöl. Anz., vol. 4, p. 120 (1881).
Am. Nat., vol. 15, p. 262 (1881).
Locard, A. (Lyon, 1882), 55 pp., portrait.
Marseul, S. A. de, *L'Abeille*, vol. 20, pp. 20–39 (1882).
Tholin, A., *Rev. d'Entom.*, vol. 5, p. 213 (1886).
Pouillaude, J., *Insecta*, vol. 8, p. 185, portrait (1918).
Wade, J. S., *Ann. Entom. Soc. Am.*, vol. 21, p. 510 (1928).
Horn, W., and Schenkling, S., *Index Litt. Entom.*, vol. 3, pp. 852–861 (1928).
* Introduced into the United States.

His great work, The histoire naturelle des Coléoptères de France, Lyon (et Paris), appeared in 37 parts 1839–1884 and contained descriptions of many families.

Opuscules Entomologiques (Paris), vol. I (1852) to vol. XVI (1875).

Monographie des Coccinellides (Paris and Lyons), vol. I, 292 pp. (1866); vol. II, 112 pp. (1867); vol. III, 66 pp. (1870).

His collections are in the Institute of St. Marie in Chamond (Loire), France.

Nunenmacher, Frederick William (Fig. 225). Born in Oakland, California, March 28, 1870; at present residing at 11 Arbor Drive, Piedmont, California. Although not school-trained in entomology, he has by boundless enthusiasm, unusual energy, and hard work, accomplished what few other men would attempt and became one of the most successful collectors of rare insects in the west. He first began collecting in 1886 and for many years he has spent his summers in the country and mountains, as is shown by the following outline which he kindly furnished at my request: May and June, 1886, August, 1890, and May, 1896, in the Santa Cruz Mountains; May and June, 1900, in Sonoma County; May, 1906, from Placerville to Strawberry in Placer County; September, October, and November, 1906, in Benson and Nogales, Arizona, and Sonora, Mexico; 1907 and 1908, all of Esmeralda County, Nevada; May and June, 1910, on foot through Del Norte County, California, to Grants Pass, Oregon; May, June, and July, 1913, by horse and wagon from Piedmont to Klamath Lake, Goose Lake, Lake Tahoe, Santa Barbara County and return; May, June, and July, 1914, by horse and wagon through Tuolumne and Merced counties; May,

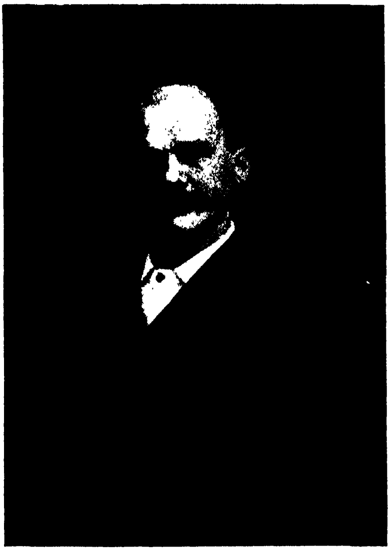

Fig. 225.—Frederick William Nunenmacher (1870–), a very successful collector of the rarer Coleoptera of the West and a specialist in the family Coccinellidæ. (Photograph taken about 1914.)

1917, Plumas County; August, 1917, Denio and southeastern Oregon; 1918, Trinity and Humboldt counties; 1926 by auto from Piedmont to Reno, Nevada. On these and other trips he took many fine new or rare species, all of which were named and described by specialists in the United States and Europe. Although he does not have an exact record of his captures he furnished the following species of Coleoptera, some of which were in large series:

Thomas L. Casey	54 new species
Frank E. Blaisdell	36 " "
H. C. Fall	9 " "
J. Weise	3 " "
W. Horn	4 " "
E. C. Van Dyke	2 " "
C. F. A. Schæffer	7 " "
W. T. Davis	4 " "
Hans Wagner	3 " "
F. C. Wellman	2 " "
E. Liljeblad	4 " "

He was specially successful in collecting *Omus* and secured a great many new varieties and some new species. In addition to Coleoptera he also took large series in other orders of insects.

He described the following new species of Coccinellidæ:[260]

Coccinella vandykei Nun.
humboldtiensis Nun.
bridwelli Nun.
Brachyacantha blaisdelli Nun.
manni Nun.
lengi Nun.
Psyllobora kœbelei Nun.
Axion incompletus Nun.
Hyperaspis lateralis var. *flammula* Nun.
wellmani Nun.
wolcotti Nun.
ploribunda Nun.
idæ Nun.
falli Nun.
Exoplectra brasiliensis Nun.
Agrabia sicardi Nun.
Scymnillus cochisiensis Nun.

Some Coleoptera named for Nunenmacher are:

Schizillus nunenmacheri Blaisd. (Nevada).
Xylotrechus nunenmacheri Van Dyke (Oregon).

[260] *Entom. News*, vol. 20, pp. 161–162 (1909); vol. 22, pp. 71–74 (1911); vol. 23, pp. 448–451 (1912); vol. 24, p. 76 (1913).

Eleodes nunenmacheri Blaisd. (California, Oregon).
Eschatoporis nunenmacheri Blaisd. (California).
Apion nunenmacheri Wagn. (Arizona).
Hyperaspis nunenmacheri Casey (California).
Mordella nunemacheri Lilj. (Arizona).
Lytta nunenmacheri Wellm. (California).
Omus nunenmacheri Horn (California).
Pachybrachys nunenmacheri Fall (Arizona).
Charistena nunenmacheri Weise (Arizona).

His collection of Coccinellidæ consists of 25,000 pinned specimens representing 3,200 species and varieties, and 125 types and cotypes, while his general collection of Coleoptera comprises 150,000 pinned specimens.

Olivier, Guillaume Antoine [261] (Fig. 226). Born at Arcs near Fréjus, France, January 19, 1756; died at Lyons, August 11, 1814. Eminent French naturalist and entomologist. He studied medicine at Montpelier and in so doing he became interested in natural history chiefly through his intercourses with the naturalist, Pierre Marie Auguste Broussonnet (1761–1807). Upon completing his medical course he returned to his native place and finding medicine unattractive and unprofitable he was employed, through the aid of Broussonnet, to undertake a statistical and economic study of the natural products in the vicinity of Paris, which work was finished in such a thorough and commendable manner that he was engaged by Gigot d'Orcy, a wealthy amateur entomologist, to collect insects in Holland, England, and other countries. This opportunity enabled him to procure material for his Encyclopédie méthodique [262] and his great work on Coleoptera.[263]

[261] Olivier, E., *G. A. Olivier, Sa vie, ses travaux, ses voyages* (Moulins, 1880), 98 pp., portrait.
Silvestre, A. F., *Soc. d'Agr. du dép. de la Seine, Sci. Pub.* (Paris, April 9, 1815), 23 pp.
Cuvier, G., *Inst. de France* (Jan. 8, 1816).
Swainson, W., *Bibliog. Zoöl.*, pp. 279–281 (1840).
Hagen, H. A., *Bibliot. Entom.*, vol. 2, pp. 20–21 (1863).
Marseul, S. A. de, *L'Abeille*, vol. 22, pp. 121–124 (1884).
Dow, R. P., *Bul. Brooklyn Entom. Soc.*, vol. 8, p. 39 (1913); vol. 9, p. 9 (1914).
Insecta, vol. 7, nos. 73–84, portrait on cover (1917).
Horn, W., *Suppl. Entom.*, no. 12, p. 92 (March 15. 1926).
Wade, J. S., *Ann. Entom. Soc. Am.*, vol. 21, p. 510 (1926).
Horn, W., and Schenkling, S., *Index Litt. Entom.*, vol. 3, pp. 899–900 (1928).

[262] *Encyclopédie méthodique. Dictionnaire des insectes* (Paris, Pankouke, 1789–1825), 10 vols., 389 pls. (vols. 1 and 2 not entomological.)

[263] *Entomologie, ou Histoire Naturelle des insectes, avec leurs caractères génériques et spécifiques, leur description, leur synonymie et leur figure enluminée.* Coléoptères (Paris, Baudonin, 1789–1808), 6 vols., 363 col. pls.

"It having been determined, by one of the parties which held temporary authority during the revolution, that a mission should be sent to Persia to establish commercial relations with that country, Olivier and Bruguière[264] were commissioned to accompany it in the capacity of naturalists. On this expedition Olivier was engaged six years,[265] during which he suffered much inconvenience, in consequence of the minister, Roland, the projector of the mission, having been driven from power, and his successors disregarding the object he had in view. He returned to France in December, 1798, bringing with him large collections in natural history.[266] These were collected in European and Asiatic Turkey, Asia Minor, Persia, Egypt, and various eastern Mediterranean Islands. Having sufficient fortune to maintain himself he set about describing and publishing material on the insects and other animals thus collected.[267] He was appointed Professor of Zoölogy of the Veterinary School at Alfort and became a member of the Institute, January 26, 1800. He became nationally known as a great entomologist and was visited by most of the contemporaries of the times, being specially intimate with Fabricius. He was a patron, protector, and pro-

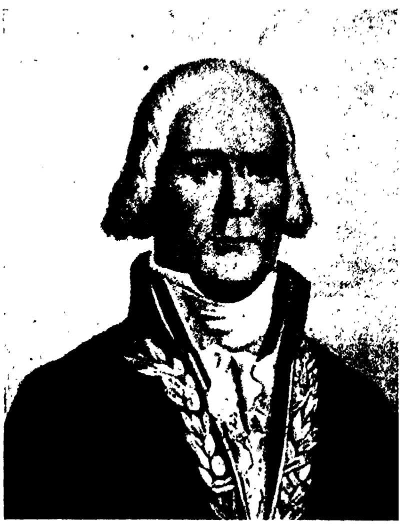

FIG. 226.—Guillaume Antoine Olivier (1756–1814), one of the greatest of the early French naturalists and an entomologist of high standing. He was a close friend of J. C. Fabricius and a patron of P. A. Latreille. (From Insecta, 1917.)

[264] Citizen Bruguière, whose name appears among those of the members of the Société Entomologique de France (elected 1832), was a merchant of Nîmes, Gard, France.

[265] The expedition left Paris, November 7, 1792, but did not finally sail from Marseilles until April 22, 1793.

[266] Olivier, G. A., *Voyage dans l'Empire Ottoman, l'Egypt, et la Perse* (Paris, 1807), 3 vols., 17 pls.
Translated into English (London, Longman and Rees, 1801), 2 vols.; vol. I, 382 pp.; vol. II, 377 pp. (plates omitted).

[267] These were also described in his *Entomologie, ou Histoire Naturelle des insectes*, etc., *op. cit.*

vider of Latreille during the revolutionary period from 1810 to 1814.

"In the latter part of his life, his health, which had been very robust, gave way, and he travelled through different parts of Europe to restore it; but he was found dead in his bed at Lyons, on the 1st of October, 1814, his disorder proving to be aneurism of the aorta, the existence of which had not been suspected by his physicians."

His extensive collections are now largely in the Museum at Paris; a small portion being in the Museum of Edinburgh, Scotland.

Olivier added some 87 new species of American insects, among which are the following interesting species:

Flat-headed apple tree borer, *Chrysobothris femorata* Olivier.
Plagiate ladybird beetle, *Axion plagiatum* (Olivier).
Ribbed pine borer, *Rhagium lineatum* Olivier.
Plum leaf beetle, *Nodonota tristis* (Olivier).
Black-legged tortoise beetle, *Jonthonota nigripes* (Olivier).
Curlew beetle, *Sphenophorus cariosus* (Olivier).
Odontomyia cincta Olivier.
Pigeon louse fly, *Lynchia brunnea* Olivier.
The Angoumois grain moth, *Sitotroga cerealella* (Olivier).

Osborn, Herbert (Fig. 227). Born at Lafayette, Wisconsin, March 19, 1856; at present research professor of zoölogy and entomology, Ohio State University, and director of the Ohio Biological Survey. He and Comstock have been the greatest teachers of entomology in this country. He first attended Iowa College, Grinnell, Iowa, a short time and in 1876 entered Iowa State College where he graduated with the degree of B. S. in 1879. From the same institution he received the degree of M. S. in 1880 and the honorary degree of Sc. D. in 1916. At his Alma Mater he was assistant in zoölogy and entomology, 1880–1883; assistant professor, 1883–1885; professor 1885–1898, and entomologist of the Iowa Agricultural Experiment Station, 1890–1898. He was field agent in the Division of Entomology, U. S. Department of Agriculture, 1885–1894; professor of zoölogy and entomology, Ohio State University, 1898–1916; research professor since 1916; director Lake laboratory Ohio State University, 1898–1919; director Ohio Biological Survey since 1912; consulting entomologist, Maine Agricultural Experiment Station, since 1913; trustee research fund, Ohio Academy of Sciences, Tropical Plant Research Foundation;

and of Biological Abstracts since 1926. In addition he has had short connections with the N. Y. Forestry School, 1920; North Carolina Agricultural Experiment Station, 1919; Florida Agricultural Experiment Station, 1921, and the Mississippi State Plant Board, 1922. He was also in charge of the entomological exhibit of the Agricultural Experiment Stations at the World Columbian Exposition in 1893. For nearly fifty years he has been connected with the organization, administration, and teaching of zoölogy and entomology and for a number of years has specially directed the research work of graduate students. He has probably trained more entomologists in America than any other teacher and his students are now to be found in every state in this country and in most foreign countries and many of them are in positions of great responsibility. These students have a large organization known as the Osborn Club which has for many years met annually with their great teacher.

FIG. 227.—Herbert Osborn (1856–) is one of the greatest teachers of entomology and a systematist, author, and editor of first rank in this country. The large membership in the Osborn Club testifies to the great influence he has exerted upon the entomological thought of the world to-day. (Photograph received in 1928.)

In addition to his large contributions to the teaching of entomology and in the field of economic entomology, he was one of the early students of the Anoplura and Thysanoptera and has been a leader in the systematic study of the leafhoppers, Cicadellidæ, and other families of Homoptera, and the Tingidæ in the Hemiptera.

Osborn has held many high positions in scientific organizations having been president of the Iowa Academy of Sciences, 1887; American Association of Economic Entomologists, 1898; Ohio Academy of Sciences, 1904; American Microscopical Society, 1907–

1909; Entomological Society of America, 1911; and the Society for the promotion of Agricultural Sciences, 1917–1919; vice-president (Chairman Section F.) the American Association for the Advancement of Science, 1917; editor of the Proceedings of the Iowa Academy of Sciences, 1890–1898; and of the Annals of the Entomological Society of America, 1908–1929.

He has studied and attended congresses in England, France, Germany, Austria, and Italy in 1894–1895; in Holland, Belgium, Germany, Austria, Dalmatia, Italy, Switzerland, and France in 1910; and in England and Scotland in 1912. In America he has traveled extensively and has been in personal contact with all of the entomologists for many years. He has collected throughout the United States and in Mexico, 1891–1892; Hawaii, 1924; Cuba, 1925; Canal Zone, Panama, and Costa Rica, 1927. His private collection of Homoptera and Hemiptera contains 60,000 specimens including many types.

Some of the more important of the very many papers written by him are:

Classification of Hemiptera, Entom. Am., vol. 1, pp. 21–27 (1885).

Insects affecting domestic animals, U. S. Dept. Agr., Div. Entom., Bul. 5, n. s., 302 pp., 170 figs., 5 pls. (1896).

Contributions to the hemipterous fauna of Iowa (with Ball, E. D.), Iowa Acad. Sci., Proc., vol. 4, pp. 172–234 (1897).

Studies of North American Jassoidea (with Ball, E. D.), Davenport Acad. Sci., Proc., vol. 7, pp. 45–100 (1898).

The Hessian fly in the United States, U. S. Dept. Agr., Div. Entom., Bul. 16, n. s., 57 pp., 8 figs., 2 pls. (1898).

Jassidæ of New York State, Ohio State Univ., Univ. Bul. Ser. 9, no. 24, Dept. Zoöl & Entom. no. 24, pp. 498–545, figs. 22–24 (1905). Reprint from 20th Rept. N. Y. State Entom., pp. 498–545 (1905).

Economic zoölogy (New York, Macmillan Co., 1908), xv+490 pp. 269 figs.

The habits of insects as a factor in classification, Ann. Entom. Soc. Am., vol. 1, pp. 70–84, pl. ii (1908).

Remarks on the genus Scaphoides *with a revised key and descriptions of new North American species*, Ohio State Univ., Contrib. Dept. Zoöl. & Entom., no. 34, pp. 249–261 (1911).

Leafhoppers affecting cereals, grasses, and forage crops, U. S. Dept. Agr., Bur. Entom., Bul. 108, 123 pp. (1912).

Life histories of leafhoppers of Maine, Maine Agr. Expt. Sta., Bul. 248, pp. 53–80, 8 figs., pls. 9–13 (1916).

Agricultural entomology (Philad. & N. Y., Lea & Febiger, 1916), 347 pp., 252 figs., 1 col. pl.

Studies of life histories of froghoppers of Maine, Maine Agr. Expt. Sta., Bul. 254, pp. 265–288, figs. 44–50 (1916).

The Tingitoidea of Ohio (with Drake, C. J.), Ohio State Univ., Bull. 20, no. 35, Ohio Biol. Surv. Bul. 8, vol. 2, pp. 213–251, 9 figs., pls. vii–x (1916).

An ecological study of the Hemiptera of the Cranberry Lake region, New York (with Drake, C. J.), N. Y. State College of Forestry, Syracuse Univ., Tech. Pub. 16, vol. 22, pp. 5–24, 12 figs., 1 map (1922).

Homoptera in the vicinity of Cranberry Lake, ibid., pp. 24–104, figs. 13–44 (1922).

The genus Phlepsius *in North America*, (with Lathrop, F. H.), Ann. Entom. Soc. Am., vol. 16, pp. 310–349, 9 figs., pls. xxii–xxxiii (1923).

Faunistic and ecological notes on Cuban Homoptera, ibid., vol. 19, pp. 335–363, pl. xxx (1926).

The leafhoppers of Ohio, Ohio State Univ. Bul., vol. 32, no. 27, May 31, 1928, Ohio Biol. Surv. Bul. 14, vol. 3, no. 4, pp. 199–374, 111 figs. (Sept., 1928).

Some common insects named by Osborn are:

Menopon alternatum Osborn.
Colpocephalum kelloggi Osborn.
Gopher louse, *Trichodectes geomydis* Osborn.
Trichodectes thoracicus Osborn.
Philopterus fuscoventralis Osborn.
sialii (Osborn).
Degeeriella cordata Osborn.
Western ground squirrel louse, *Enderlienellus suturalis* (Osborn).
White-footed mouse louse, *Hoplopleura hesperomydis* (Osborn).
Sheep foot louse, *Linognathus pedalis* (Osborn).
Flying squirrel louse, *Neohæmatopinus sciuropteri* (Osborn).
Fur seal louse, *Antarctophthirus callorhini* Osborn (Alaska).
Acinopterus aridellus Osborn.

Some of the insects bearing his name are:

Colpocephalum osborni Kellogg.
Rhytidolomia osborni (Van D.).
Clastoptera osborni Gill. & Baker.
Deltocephalus osborni Van D.
Eutettix osborni Ball.
Thamnotettix osborni Ball.
Balclutha osborni Van D.
Erythroneura osborni De L.
Scolops osborni Ball.
Liburnia osborni Van D.

Osten Sacken, Carl Robert[268] (Fig. 228). Born at St. Peters-

[268] Osten Sacken, C. R., *Record of my life work in entomology* (Cambridge, Mass., 1903), pts. I & II, 204 pp., 3 pls.; pt. III (Heidelberg, 1904), pp. 205–242, portrait. (Complete bibliography.)
Can. Entom., vol. 35, pp. 344–346 (1903).
Ann. Entom. Soc. Belg., vol. 50, p. 162 (1906).
Bryan, G. H., *Nature*, vol. 74, pp. 180–181 (1906).

burg, Russia, August 21, 1828; died at Heidelberg, Germany, May 20, 1906. Diplomat and entomologist. In his autobiography, Osten Sacken divides his life work into three periods as follows:

FIG. 228.—Baron Carl Robert Osten Sacken (1828–1906), Russian diplomat and entomologist, who became one of the leading dipterists in America and whose autobiography gives a splendid historical background of entomology in his time. (From his autobiography, 1904.)

The first period began in 1849, when, at the age of twenty-one, he entered the Imperial Foreign Office in St. Petersburg. He collected in all orders of insects, excepting Lepidoptera and published two papers on Tipulidæ and a pamphlet on an insect survey in the environs of St. Petersburg.

The second period began in 1856, when he became Secretary of the Russian Legation and Consul General of Russia in New York City, and represents his activities in the United States and until he went to Germany in 1877. Most of his work on the Diptera was done during this period. In 1858 he published the Catalogue of the Described Diptera,[269] and published many short papers in various entomological journals. His last work on the Cynipidæ appeared in 1870.[270] He resigned his official position in 1871 and made several

Kusnezov, N. J., *Rev. Russe*, vol. 6, pp. 382–383 (1906).
Aldrich, J. M., *Entom. News*, vol. 17, pp. 269–272, portrait (1906).
Johnson, C. W., *Entom. News*, vol. 17, pp. 273–275 (1906).
Entomologist, vol. 39, p. 192 (1906).
Verrall, G. H., *Entom. Mthly. Mag.*, vol. 42, pp. 234–235 (1906).
Bethune, C. J. S., *Can. Entom.*, vol. 38, p. 238 (1906).
Korschelt, E., *Verh. Deutsch. Zoöl. Ges.*, vol. 17, p. 19 (1907).
Smith, J. B., *Pop. Sci. Mthly.*, vol. 76, p. 473 (1910).
Wheeler, W. M., *Social life among the insects* (New York, Harcourt, Brace & Co., 1923), pp. 311–319. Notes on the "Bugonia."
Wade, J. S., *Ann. Entom. Soc. Am.*, vol. 21, p. 511 (1928).
Horn, W., and Schenkling, S., *Index Litt. Entom.*, vol. 3, pp. 904–905 (1928); vol. 4, p. 1420 (1929).

[269] *Smithsonian Inst. Miscl. Coll.*, vol. 3, xx+192 pp. (Jan., 1858).

[270] *On the Cynipidæ of N. Am. oaks and their galls*, Proc. Entom. Soc., Phila., vol. 1, pp. 47–72 (1861); pp. 241–253 (1862).
Contributions to the natural history of the Cynipidæ of the U. S. and their galls, *ibid.*, vol. 2, pp. 33–49 (1863); vol. 4, pp. 331–380 (1865).
Trans. Am. Entom. Soc., vol. 3, pp. 54–64 (1870).

visits to Russia, but spent the last four, 1873–1877, in the United States as a private citizen, during which time he collected extensively throughout the country and made a trip to California.[271] In 1877 he published the Catalogue of North American [272] and Western Diptera.[273]

The third period, beginning in 1877, and extending until his death in 1906, was spent almost entirely at Heidelberg, Germany. One of his greatest contributions to the entomology of the United States was the packing and transmitting the Collection of North American Diptera [274] of Hermann Loew, from Guben, Germany, to the Cambridge Museum of Comparative Zoölogy, where it arrived safely.

In summing up his biography, G. H. Verrall [275] states:

> In the death of C. R. Osten Sacken, which took place at Heidelberg on May 20th last, it may truly be said that Dipterology—or, in fact, Entomology—has lost one of its brightest ornaments. For many years his general knowledge of the Diptera exceeded that of any other student of the Order. In many ways he constituted the *beau ideal* of a scientific entomologist; absolute master of numerous languages, independence of means, social rank, retentive memory, accurate observation, possessor of an almost perfect library of works upon Dipterology, and polished manners—these qualities all combined enabled him to hold the highest rank in his special branch of science. The last work he published was his autobiography, issued when he was seventy-five years old, and since then (three years ago) nothing has appeared from his pen. In a short notice it is impossible to do justice to his work, but it is duly appreciated by all those who have had opportunities to profit from it.

His collection is somewhat divided. The larger portion of North American Diptera is at the Museum of Comparative Zoölogy, Cambridge, Mass., while a portion is in the collections of the American Entomological Society, Philadelphia, Pa., and his early Russian and European collection is at the Museum of Leningrad (St. Petersburg), Russia.

Some of the common Western insects described by Osten Sacken are:

[271] On this trip he collected among other insects, *Hoplia sackeni* Leconte, at Summit Lake, Fresno County, California [and V. L. Kellogg also named the fly *Blepharicera osten-sackeni* for him]. Concerning his visit to California in 1875–1876 Osten Sacken, in his biographical sketch, part third, pp. 215–217 (1904), gives a most interesting account.

[272] Smithsonian Miscl. Coll. (ed. 2), pp. xlviii+276 (1878).

[273] U. S. Geol. & Geog. Surv. Terr., *Bul. 3*, no. 2, pp. 189–354 (1887). Chiefly from California.

[274] This collection contained approximately 13,000 original types and 16,000 other species.

[275] *Entomologist*, vol. 39, p. 192 (1906).

Chrysops noctifer O. S.
proclivis O. S.
surdus O. S.
Western horsefly, *Tabanus punctifer* O. S.
Laphria vultur O. S.
Anthrax alpha O. S.
Aphœbantus mus (O. S.).
Lemur syrphid, *Baccha lemur* O. S.
Bird syrphid, *Eupeodes volucris* O. S.
Western syrphid, *Syrphus opinator* O. S.
Cruel syrphid, *Syrphus torvus* O. S.
Echinid oak gall, *Dryophanta echina* (O. S.).

The following are a few of the dipterous insects bearing his name:

Sacken's crane fly, *Bittacomorpha sackeni* Rœder.
Sacken's beefly, *Heterostylum sackeni* Will.
Sacken's robber fly, *Dasyllis sackeni* Banks.
Sacken's syrphid fly, *Mallota sackeni*.
Rhynchocephalus sackeni Will.

Packard, Alpheus Spring [276] (Fig. 229). Born at Brunswick, Maine, February 19, 1839; died at Providence, Rhode Island, February 14, 1905. He was one of America's greatest entomologists and did so much for general entomology in this country that he may be called the Westwood of America. He graduated from Bowdoin College in 1861. After qualifying in medicine he served as Assistant Surgeon in the Civil War during 1864–1865. At the end of the war he became librarian and custodian of the Boston Society of Natural History in 1865. He was afterwards curator of the Essex Institute and still later of the Peabody Academy of Science in 1867, and also became director of the latter after some years. He

[276] Ballou, W. H., *Field*, Chicago, pp. 396–398 (Jan., 1880).
Henshaw, S., *U. S. Dept. Agr.*, Div. Entom., Bul. 16, pp. 1–49 (1887).
Benjamin, M., *Harper's Weekly*, vol. 34, pp. 925–926, portrait (1890).
Can. Entom., vol. 37, pp. 111–112 (1905).
Entom. News, vol. 16, pp. 97–98, portrait (1905).
Kingsley, J. S., *Pop. Sci. Mthly.*, vol. 33, pp. 145, portrait, 260–267 (1888); *Science*, n. s., vol. 21, pp. 401–404 (1905).
Barus, C., *Science*, n. s., vol. 21, pp. 404–406 (1905).
Mead, A. D., *Pop. Sci. Mthly.*, vol. 67, pp. 43–48, portrait (1905).
Jackson, R. T., *Psyche*, vol. 12, pp. 36–38 (1905).
Holland, W. J., *Entom. Mthly. Mag.*, vol. 41, pp. 140–141 (1905).
Kirby, W. F., *Entomologist*, vol. 38, pp. 143–144 (1905).
Smith, J. B., *Psyche*, vol. 12, pp. 33–35, portrait (1905); *Pop. Sci. Mthly.*, vol. 76, p. 473, portrait (1910).
Cockerell, T. D. A., *Biog. Mem. Nat. Acad. Sci.*, vol. 9, pp. 181–236, portrait (1920).
Wade, J. S., *Ann. Entom. Soc. Am.*, vol. 21, p. 511 (1928).
Horn, W., and Schenkling, S., *Index Litt. Entom.*, vol. 3, p. 907 (1928).

was a member of the U. S. Entomological Commission with Cyrus Thomas and C. V. Riley from 1877–1882 and was Professor of Zoölogy and Geology at Brown University from 1878 until the time of his death. Packard was a well-trained general naturalist and was one of the founders and for twenty-four years (1839–1905) chief editor of the American Naturalist. He wrote on Crustacea, Myriapoda, systematic and economic entomology, geology, paleontology and related subjects, but he was chiefly interested in insects and worked in all orders. He particularly studied ontogeny and phylogeny and arranged the various orders in a system of his own. He was a member of all the important entomological organizations in America and Europe. On January 3, 1888, he was elected an honorary member of the California Academy of Sciences.

FIG. 229.—Alpheus Spring Packard (1839–1905), one of the greatest American entomologists, author of many texts, editor of the American Naturalist for twenty-four years, member of the U. S. Entomological Commission, and a systematist of note. (From J. B. Smith, Psyche, 1905.)

Although he wrote a great many papers on a wide variety of entomological subjects he is chiefly known for the many books which he prepared at a time when they were so urgently needed by those who were drawn to the virgin field of entomology. These are as follows:

Books:

Guide to the study of insects (N. Y., Henry Holt & Co., 1869), 12+715 pp., 668 figs., 15 pls.

Our common insects (Boston, Estes & Lauriat, 1873), 225 pp., 268 figs.

Half hours with insects (Boston, Estes & Lauriat, 1877), viii+384 pp.

Zoölogy (N. Y., H. Holt & Co., 1883), 334 pp.

Entomology for beginners (N. Y., Henry Holt & Co., 1888), 16+367 pp., 273 figs.

A text book of entomology (N. Y., Macmillan Co., 1898), 17+729 pp., 654 figs.

Systematic Entomology:

The Humble bees of New England and their parasites, etc., Essex Inst., Proc., vol. 4, pp. 107–140 (1864).

Cave fauna of North America, Nat. Acad. Sci., Mem., vol. 4, pt. 1, pp. 3–156, XXVII pls., 1 map (1888).

Monograph of the Geometrid Moths or Phalænidæ of the United States, U. S. Geol. Surv. Terr., F. V. Hayden's Rept., vol. 10 (1876).

Monograph of the Bombycine Moths of America north of Mexico, including their transformations and origin of the larval markings, Mem. Nat. Acad. Sci., I, vol. 7, 287 pp., 49 pls., 9 maps (1895); II, vol. 9, 147 pp., 61 pls. (1905); III, vol. 12, 276 pp., 113 pls. (1914). (Ed. by T. D. A. Cockerell.)

Economic Entomology:

Injurious insects, new and little known (Boston, 1870).

Insects injurious to forest and shade trees, U. S. Entom. Comm., Bul. 7, 275 pp., 100 figs. (1881).

Revised in *Fifth Rept.*, U. S. Entom. Comm., 955 pp., 306 figs., 40 pls. (1890).

A century's progress in American zoölogy appeared in the American Naturalist, vol. 10, pp. 591–598 (October, 1876).

One of his latest and greatest works was a book, *Lamarck: the founder of evolution; his life and work, with translations of his writings on organic evolution* (N. Y., Longmans, Green, 1901), xii+451 pp., 3 pls., 5 portraits.

Packard described some ticks and many insects from the entire country and a number of species are worthy of note here.

Rabbit tick, *Hæmapysalis leporis-palustris* (Packard).
Winter tick, *Dermacentor albipictus* (Packard).
Fire brat, *Thermobia domestica* (Packard).
Bessels' springtail, *Entomobrya besselsi* Packard.
Skunk louse, *Trichodectes mephitidis* Packard.
California boreid, *Boreus californicus* Packard.
Glover's scale, *Lepidosaphes gloveri* Packard.
Silver-spotted halisidota, *Halisidota argentata* Packard.
Painted desert moth, *Arachnis picta* Packard.
California oak moth, *Phryganidia californica* Packard.
California tent caterpillar, *Malacosoma californica* (Packard).
Crepis snout moth, *Phlyctænia profundalis* Packard.
Apanteles lunatus (Packard).
Salt Lake fly, *Ephydra gracilis* Packard.

Peck, William Dandridge [277] (Figs. 230, 231). Born at Boston, Mass., May 8, 1763; died at Cambridge, Mass., October 8, 1822,

[277] *Boston Daily Advertiser*, vol. 35, no. 81, p. 2 (Oct. 8, 1822).
Quincy, J., *History of Harvard College*, vol. 2, pp. 329–330 (1840).
Harris, T. W., *Rept. Ins. of Mass., Inj. to Veg.*, p. 332 (1841); Flint Ed., pp. 91, 412, 461, 528 (1862).
Mass. Hist. Soc. Coll. (2), vol. 10, pp. 161–170 (1843).
Morris, J. G., *Am. Jour. Sci. & Arts* (2), vol. 1, pp. 19–20 (1846).

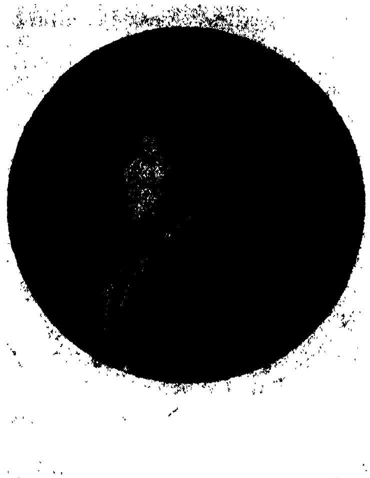

FIG. 230.—William Dandridge Peck (1763–1822), the first professor of natural history at Harvard. He published the first systematic paper on zoölogy in America and was the first native entomologist in this country. His studies of injurious insects set the standards for the development of economic entomology. (Photograph of a small engraved portrait made at the time of his European trip in 1805, and loaned by his great-grandson, L. P. Rockwood.)

America's first native entomologist.[278] He was the son of a noted naval architect and graduated from Harvard with the degree of B. A. in 1782. He afterwards went into business, but finding it uncongenial he retired to a small farm at Kittery on the coast of Maine where he spent twenty years in seclusion. Goode states that he became interested in natural history by reading a copy of Linnæus' Systema Naturæ which was obtained from a ship wrecked near his home! By self-instruction he became an authority on plants, birds, fishes, and insects. In 1794 he published the first systematic paper on Zoölogy in America: Description of four remarkable fishes, taken near Piscataqua in New Hampshire. He made a splendid collection of insects and began writing on entomological subjects in 1795 and his paper on the natural history of the cankerworm, which appeared in 1796, won a prize of $50.00 and a gold medal from

Hagen, H. A., *Bibliot. Entom.*, vol. 2, pp. 33–34 (1863).
Gray, Asa, *The Harvard Book*, vol. 1, pp. 313–314 (1875).
Winsor, J., *Memorial Hist. of Boston*, vol. 4, pp. 518–519 (1881).
Goode, G. B., Biol. Soc. Wash., *Proc.*, vol. 4, p. 34, 1886–1888 (1888); *Ann. Rept. Smithsn. Inst.*, 1897, vol. 2, pt. 2, pp. 403, 426 (1901).
Henshaw, S., *Bibliogr. Am. Econ. Entom.*, U. S. Dept. Agr., Div. Entom., pt. v, p. 91 (1896) (Bibliography).
Howard, L. O., U. S. Dept. Agr., *Yearbook*, 1899, p. 136 (1900).
True, A. C., *ibid.*, p. 161 (1900).
Kelly, H. A., *Cyclop. Am. Med. Biog.*, vol. 2, pp. 260–261 (1912).
Dow, R. P., *Bul. Brooklyn Entom. Soc.*, vol. 8, p. 71 (1913).
Kelly, H. A., and Burrage, W. L., *Am. Med. Biog.*, pp. 900–901 (1920).
Wade, J. S., *Ann. Entom. Soc. Am.*, vol. 21, p. 511 (1928).
Horn, W., and Schenkling, S., *Index Litt. Entom.*, vol. 3, p. 924 (1928); vol. 4, p. 1421 (1929).

[278] F. V. Melsheimer (1749–1814), German by birth and a Lutheran clergyman residing at Hanover, York Co., Pennsylvania, is given the place as the founder of

the Massachusetts Society for Promoting Agriculture. He was in touch with Wm. Kirby in England and sent him much valuable material.

On March 27, 1805, he was elected first professor of natural history at Harvard and inducted into office on May 14. He was authorized to study botany in Europe in preparation for his new duties, chief of which was the establishment of a botanic garden. Accordingly he spent three years studying in England, France, and Sweden. Much of his time was spent in Sweden, where he acquainted himself with the work of the great Linnæus, from whom he received his first inspirations. He described but few new species of insects being rather more interested in the economic aspects of the subject. All of his work, including the drawings, were of the first order and he set the standards for Harris and other early investigators. He was one of the founders of the American Antiquarian Society in 1812 and later vice-president, fellow of the American Academy of Arts and Sciences, member of the Massachusetts Horticultural Society and the American Philosophical Society, and warden of Christ Church, Cambridge, 1816–1819. He retained his professorship until his death in 1822.[279]

FIG. 231.—William Dandridge Peck as he appeared about 1820. (Photograph of a portrait furnished by L. P. Rockwood.)

L. P. Rockwood, Bureau of Entomology, U. S. Dept. of Agriculture, is a direct descendant of W. D. Peck. His mother, Abba Peck Rockwood, is a granddaughter of the early American entomologist. When her old home at Sterling, Mass., was broken up in

American Entomology; John Abbot (1750–1840), an Englishman in Georgia, our first great entomological artist; Thomas Say (1787–1834), the father of American Entomology; T. W. Harris (1795–1856), our pioneer economic entomologist; and Asa Fitch (1809–1879), our first official entomologist.

[279] The professorship held by him lapsed after his death. Thomas Nuttall, distinguished English botanist, was then placed in charge of the Botanic Garden. He remained until the winter of 1833–34. After his departure some instruction was given by T. W. Harris, then university librarian.

1900 much valuable material relating to W. D. Peck was destroyed. However, some things were saved which are carefully guarded by the family today. I am indebted to Mr. Rockwood for this information. Peck's chief contributions to entomology are:

The description and history of the cankerworm, Mass. Mag., vol. 7, pp. 323-327 (September, 1795); pp. 415-416, 1 pl. (October, 1795); reprinted as the *Natural history of the cankerworm*, Rules and Regulations of the Mass. Soc. for Promoting Agr., pp. 34-45, 1 pl. (1796) [Mass. Agr. Repository and Journal, Oct. 1796]; *New England Farmer*, vol. 5, pp. 393-394 (July 6, 1827). [Description of *Phalæna* (*Paleacrita*) *vernata*, sp. nov., pp. 323, 415; habits, natural history, seasons, enemies, diseases, and probable habitat of same.]

Natural history of the slugworm, Papers on Agric., Mass. Soc. for Promoting Agr., pp. 9-20, 1 pl. (1799). Separate (Boston, 1799), 14 pp., 1 pl. (Description of a tentredinid larva found on *Betula* and *Salix* and the life history and food plants of the cherry or pear slug.)

Important communication relative to the cankerworm, Mass. Agric. Repository and Journal, vol. 4, no. 1, pp. 89-92 (January, 1816). (Observations on the life history and control of the cankerworm.)

On the insects which destroy the young branches of the pear tree and the leading shoot of the Weymouth pine, *ibid.*, vol. 4, no. 3, pp. 205-211, 1 pl. (January, 1817). (Description of *Pissodes strobi* sp. nov.).

Zoöl. Jour., vol. 2, pp. 487-492 (January-April, 1825). [Description, figures, life history and control of *Scolytus pyri* sp. nov., p. 205, *Anisandrus* or *Xyleborus dispar* (Fabr.).]

Some notice of the insect which destroys the locust tree, Mass. Agric. Repository and Jour., vol. 5, no. 1, pp. 67-73, 1 pl. (January, 1818). [Descriptions and figures of *Cossus robiniæ* sp. nov. (*Prionoxystus*), and *Clytus* (*Cyllene*) *robiniæ*.]

Insects which affect the oak and cherries, *ibid.*, vol. 5, no. 3, pp. 307-313 (January, 1819). Zoöl. Jour., vol. 2, pp. 487-492 (January-April, 1826). Féruss. Bul., vol. 14, pp. 151-152 (1828). *Isis*, vol. 10, p. 1065 (1830) [Description and figures of *Stenocorus putator* sp. nov. p. 307 [*Hypermallus villosus* (Fabr.)] and of *Rhynchænus cerasi* sp. nov., p. 307 [*Conotrachelus nenuphar* (Hbst.)] and their life histories and habits.]

Of the species named by Peck two are synonymous and the remainder are valid. All are of economic importance throughout the country. They are:

Twig pruner, *Stenocorus putator* Peck—now a synonym of *Hypermallus villosus* (Fabr.).

Plum curculio, *Rhynchænus cerasi* Peck—now a synonym of *Conotrachelus nenuphar* (Hbst.).

White pine weevil, *Pissodes strobi* Peck.

Pear blight beetle, *Scolytus pyri* Peck—now *Anisandrus* (doubtfully distinct from the European, *A. dispar* Fabr.).

Spring cankerworm, *Phalæna vernata Peck*—now *Paleacrita*.

Carpenter or goat moth, *Cossus robiniæ* Peck—now *Pxionoxystus*.

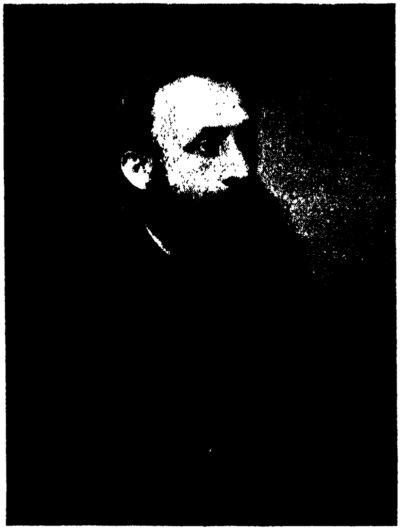

Fig. 232.—Theodore Pergande (1840–1916), faithful and efficient assistant in the U. S. Bureau of Entomology and remembered for his descriptions of aphids and splendid life history studies of insects. (From a photograph loaned by Prof. Lawrence Bruner.)

Pergande, Theodore[280] (Fig. 232). Born in Germany, December 28, 1840; died in Washington, D. C., March 16, 1916, as the then oldest member in the Bureau of Entomology. He came to the United States during the Civil War and served in the Union Army. Afterwards he became the assistant of C. V. Riley, State Entomologist of Missouri. Pergande and Otto Lugger, also an assistant of Riley, did a great deal of the work which appeared in the Missouri Reports. In 1878 he accompanied Riley to Washington and served the Bureau of Entomology faithfully to the end. He did both systematic and economic work, but got really very little of the credit due him. Some of his more valuable publications are:

Life history of two species of plant lice inhabiting both witchhazel and birch, U. S. Dept. Agr., Bur. Entom., Tech. Bul. 9, 44 pp., 21 pls. (1901).

Life history of the alder blight aphis, *ibid.*, Bul. 24, 28 pp., 12 figs. (1912).

The southern grain louse, *ibid.*, Bul. 38, n. s., pp. 1–19, pl. 1 (1902).

On some aphides affecting grains and grasses of the United States, *ibid.*, Bul. 44, n. s., pp. 1–23, figs. 1–4 (1904).

North American Phylloxerinæ affecting Hicoria and other trees, Davenport Acad. Nat. Sci., Proc., vol. 9, pp. 185–271, 21 pls. (1904).

The following common insects were named by Pergande:

Bean thrips, *Heliothrips fasciatus* Pergande.
Six-spotted thrips, *Scolothrips sexmaculatus* (Pergande).
Western thrips, *Frankliniella occidentalis* (Pergande).
Red violet aphis, *Neotoxoptera violæ* (Pergande).

[280] Bigson, H., *Can. Entom.*, vol. 48, pp. 213–214 (1916).
Entom. News, vol. 27, p. 240 (1916).
Science, n. s., vol. 43, p. 492 (1916).
Wade, J. S., *Ann. Entom. Soc. Am.*, vol. 21, p. 511 (1928).

Birch thread scale, *Xylococcus betulæ* Pergande.
Leaf cutting ant, *Atta versicolor* Pergande.

Insects named for Pergande are:

Chaff scale, *Parlatoria pergandei* Comstock.
Alder lacebug, *Corythucha pergandei* Heid.
Dasyneura pergandei Felt.
Pelecocera pergandei Will.
Ant-decapitating fly, *Apocephalus pergandei* Coq.

FIG. 233.—L'Abbé Leon Provancher (1820–1892), greatest of the early Canadian entomologists. He was a profuse writer and described many insects, especially in the orders Homoptera and Hymenoptera. (From Entom. News, 1895.)

Provancher,[281] **L'Abbé Leon** (Fig. 233). Born at Bécancourt, province of Quebec, Canada, March 10, 1820; died at Cap Rouge, Canada, March 23, 1892, at the age of 72. Educated for the Catholic ministry he was for some years Curé of Portleuf, but because of ill health he later gave up active work and moved to Cap Rouge near Quebec where he devoted much of his time to the natural sciences. Although he early studied and published on botany [282] and later wrote an "account of a pilgrimage to Jerusalem, an excursion to the West Indies, treatises on agriculture," [283] and was much interested in conchology, he is best known as an entomologist. In 1869 he began the publication of Le Naturaliste Canadien (nearly 8,000 pages) and continued it through volume 20 in 1891. His first papers on entomology commenced in his Petite Faune Entomologique du Canada; volume 1

[281] Entom. Soc. Ontario, *23d Ann. Rept.*, p. 88 (1892).
Harrington, W. H., *Can. Entom.*, vol. 24, pp. 130–131 (1892).
Entom. News, vol. 6, p. 209 (1895).
Maheux, G., Entom. Soc. Ontario, *53d Ann. Rept.*, pp. 28–30 (1922).
Wade, J. S., *Ann. Entom. Soc. Am.*, vol. 21, p. 512 (1928).

[282] His most important work in botany was his *Flore Canadienne*, which appeared in 1862. The first complete work dealing with Canadian plants.

[283] His *Le Verger Canadien*, a small work on fruit growing, appeared in 1862 and reached its fifth edition in 1885.

on Coleoptera was completed in 1877 with three supplements in 1877, 1878, 1879. Volume 2, on the Orthoptera, Neuroptera, and Hymenoptera, was begun in 1877 and completed in 1883. Additions aux Hymenoptères appeared in 1885–1889. Volume 3 on the Hemiptera was completed in 1890. The four volumes make a total of 2,506 pages. He labored under the disadvantages of being isolated from libraries, collections, and fellow workers and naturally made many entomological errors which are small enough, compared to the difficulties he encountered. His most important contributions are in the Hymenoptera [284] and Homoptera. His name appears after a number of important insects as follows:

Clover leafhopper, *Agallia sanguinolenta* (Prov.).
Oncopsis pruni (Prov.).
Empoasca unica (Prov.).
Dictyssa semivitrea (Prov.).
Odontomerus canadensis Prov.
Pœmenia vancouverensis (Prov.).
Ephialtes æqualis (Prov.).
Doryctes cingulata (Prov.).
Ephedrus incompletus Prov.
Microbracon cingulata (Prov.).

His three collections of insects are at the College de Levis and the Quebec Public Museum.

A memorial tablet to his memory was unveiled at the celebration of the 25th anniversary of his death at the Provincial Museum at Quebec, in August, 1918. This tablet, inscribed "A La Mémoire de Provancher, Naturaliste et Entomologiste, 1820–1892," was presented by the Quebec Society for the Protection of Plants. "A few years before, in the Church of Cap Rouge, where the remains of Provancher have been piously kept, Canon Hurad erected another memorial with the financial aid of the Ontario Entomological Society."

Radoshkowsky,[285] Octavius John (Bourmeister-Radoshkowsky) (Radochkowsky, Radochkoffsky, Radoschkovski, Radoszkowskii, etc.) (Fig. 234). Born in Lomza, Poland, August 7, 1820; died in

[284] In the Hymenoptera he described 923 new species.
[285] Hagen, H. A., *Bibliot. Entom.*, vol. 2, p. 57 (1863).
Horæ, Soc. Entom. Ross., vol. 30, pp. i–vi, portrait (1896).
Horn, W., and Schenkling, S., *Index Litt. Entom.*, vol. 3, p. 964 (1928).

Warsaw, Poland, May 1, 1895. The following translation of his biography which appeared in Horæ was made by Katherine de Savine, student at the University of California, in September, 1929:

The oldest of the charter members of the Russian Entomological Society, its former president and honorary member, Octavius John Bourmeister-Radoshkowsky, died in Warsaw after a serious illness on the 1st of May, 1895, in the 75th year of his life. He enjoyed a great popularity in the Society which is easily explained by the importance attached to his membership. The name of the deceased is blended with the peaceful period of the development of the Society, which was then just beginning to hold its ground after the first unsettled and turbulent years of its existence.

FIG. 234.—Octavius John Radoshkowsky (1820–1895), Russian military official and entomologist, who described insects from the vast Russian Empire collected by I. G. Vosnesensky. (From Horæ, 1896.)

Radoshkowsky was elected president in 1867 and remained in office until 1880, when, after a dangerous illness and on account of family circumstances, he was forced to leave Petrograd and settle down in a more southern region, e. g. Warsaw.

Radoshkowsky comes from the nobility of the Polish Kingdom; he was born on August 7, 1820 in Lomza and received his primary education in Warsaw; when the University was closed there he continued his education in the higher classes of the Technical Faculty; in 1846 he finished, ranking first in the officers' classes of the Artillery School (now Academy) and his name was added to the others on the marble board. He served in the cavalry-artillery and at different times lectured on higher mathematics and artillery in the Artillery School, as well as on fire-arms in the Officers' Shooting School. He retired from service in 1879 with the rank of Lieutenant-General.

When still a young man Radoshkowsky liked to study entomology; although he was generally interested in all insects and made reports concerning the various kinds at the meetings of the Society, he was especially interested in the rich and varied groups belonging to the Hymenoptera, particularly the bees and wasps. As a specialist in Hymenoptera Radoshkowsky was well known and he possessed a rich and varied collection of these insects in which were included, not only many interesting and rare specimens, but also many types, described abroad and by the collector himself. Being preëminently a

systematist and a faunist, he described a great number of new species of the Hymenoptera, mostly from the various parts of the Russian Empire and from the contiguous countries; besides he added to many of his works tables of excellently executed drawings, which adorn the publications of the Society and facilitate the acquaintance with the exterior of the described forms. The study of Hymenoptera forced Radoshkowsky to undertake repeated trips abroad, where he studied the types collected in the museums of London, Paris, Berlin, Vienna, and Geneva.

But the greatest value of Radoshkowsky to the Society was in his being its president. It is enough to say that the Society owed the greatest part of its property, its finances, its home to the deceased. There was no end to his interests in the welfare of the Society. When it lost its first property and was forced to rent an apartment in a private house, Radoshkowsky obtained an annual subsidy for the amount of 2500 roubles. It was owing to him that the Society received for the second time property, which it has occupied until the present time; the subsidies for the completion of the library and for the scientific trips of the various members of the Society. As a result of his petitions many of the members, before laboring without remuneration, were given imperial rewards. In 1875, through the solicitations of Radoshkowsky, the Society received a subsidy of 3000 roubles for the exploration of the Caucasus, from the Entomological point of view, and this expedition, due to the careful planning of the President, proved not only successful, but was enjoyed in great comfort by the members thereof.

It would be impossible to enumerate in this sketch all of the innumerable services rendered to the Entomological Society by the deceased. He was its sincere friend, ready to do anything in his power to further its welfare and interests.

Among the insects described from various parts of the Russian Empire were those collected by I. G. Vosnesensky in Russian North America. One of these, the common yellow-faced bumblebee, *Bremus vosnesenskii*,[286] was collected in California and named in his honor by Radoshkowsky.[287]

Reakirt, Tryon. Although I was unable to find any biographical data concerning Reakirt, it is well known that he collected Lepidoptera throughout California and more particularly in the vicinities of Los Angeles and Sacramento, as well as in the Rocky Mountains. He published at least one paper on butterflies.[288]

[286] Essig, E. O., *Insects of Western No. Am.*, p. 901, fig. 763 (1926).

[287] *Bul. Soc. Nat. Moscow*, vol. 35, Pt. 2, p. 589, n. 13, ♀ ♂ T. 6, F1 (1862). This species is listed as a synonym of *B. californicus* Smith by C. G. De Dalla Torre, *Cat. Hymenopterorum*, vol. 9, p. 513 (1894). T. H. Frison considers it to be a valid species, *Proc. Calif. Acad. Sci.* (4), vol. 16, no. 12, pp. 368–369 (1927). He gives the distribution as California, Oregon, and Washington.

[288] *Coloradian butterflies*, Proc. Entom. Soc., Phila., vol. 6, pp. 122–151 (1866–1867).

Reiche, Louis Jerome [289] (Fig. 235). Born in Gerinchem, Holland, December 20, 1799; died in Paris, May 16, 1890. He was a celebrated French entomologist who was one of the founders of the Société Entomologique de France, and elected honorary member in 1874. He was a manufacturer and merchant in Paris, but he had severe losses following the war of 1870. However, prior to this he traveled much in Europe, amassed a large collection and published 65 papers chiefly on Coleoptera, which were largely published in the Annales. He named two common important cicindelids of the west: *Omus audouini* Reiche and *Omus dejeani* Reiche. These he states were taken in the mountains of western Oregon in 1836,[290] but it is believed that John K. Townsend must have collected them there in 1834 or 1835. His great collections are scattered in private hands and in many of the great European Museums. The greater portions are in the collections of R. Oberthur in France.

FIG. 235.—Louis Jerome Reiche (1799–1890), a merchant in Paris, who became interested in entomology and described many species of Coleoptera including two interesting tiger beetles believed to have been collected in the West in 1836. (From C. de Barneville Brisout, 1890.)

Ricksecker, Lucius Edgar [291] (Fig. 236). Born at Nazareth, Pennsylvania, January 14, 1841; died at San Diego, California, January 30, 1913. He was a corporal in the 153d Pennsylvania volunteers in the Civil War during 1862–1863. In 1868 he removed to Salt Lake City where he was in charge of the Division Engineer's office of the Union Pacific Railroad and later served in a similar

[289] Hagen, H. A., *Bibliot. Entom.*, vol. 2, pp. 67–69 (1863).
Barneville Brisout, C. de, *Ann. Soc. Entom. France* (6), vol. 10, pp. 559–562, portrait (1890).
Entom. Mthly. Mag., vol. 26, p. 163 (1890).
Horn, W., and Schenkling, S., *Index Litt. Entom.*, vol. 3, pp. 979–983 (1928).
[290] *Sur le genre Omus d'Eschscholtz, et description de deux nouvelles espèces*, Ann. Soc. Entom. France, vol. 7, pp. 297–302, pl. 10 (1838).
[291] Fall, H. C., *Entom. News*, vol. 24, pp. 239–240 (1913).

capacity for the Northern Pacific Railroad at Spokane, Washington. Although educated as an engineer, he was always interested in natural history. He collected on the sand dunes about San Francisco and in Marin County until he went to Spokane in 1881. Through the influence of O. B. Johnson, at the University of Washington, Seattle, he became even more interested in insects and was soon celebrated as a collector of Coleoptera along the Pacific Coast. He collected, reared, and sold insects and also amassed considerable personal collections of insects, shells, mosses, and Indian relics, which were destroyed at Santa Rosa by the earthquake and fire of 1906. The arrowheads and other indestructible Indian relics were dug from the ashes and presented to the California Academy of Sciences. He lived in California from 1873 until his death and was for many years County Surveyor of Sonoma County and City Engineer of Santa Rosa. He moved to San Diego in 1907 and collected and sold Lepidoptera from that region.

His wife, Henriette E. McFarland Ricksecker, whom he married in 1881, very kindly furnished the photo of Mr. Ricksecker taken on his sixty-fifth birthday in 1906. A daughter, Mrs. Helen R. Skaggs, lives at Santa Rosa.

Mr. Ricksecker was a charter member of the Pacific Coast Entomological Society which was organized at San Francisco in 1901. Concerning him H. C. Fall writes:

> A correspondent for many years previously, I have for the past dozen years, been personally acquainted with Mr. Ricksecker. I found him a good naturalist, well and widely informed; a courteous gentleman; a firm friend, generous and just in all his dealings—in short, a man that it was worth while to know.

He published four papers and wrote many notes for others on Coleoptera and was chiefly interested in the habits of *Pleocoma*. Two fine species of Coleoptera were named for him by Horn and LeConte, as well as a number of other insects as follows:

Pleocoma rickseckeri Horn. Taken near Sylvania, Cal., by Ricksecker on November 28, 1887.

Cychrus rickseckeri Lec. Subsp. of *C. hemphilli* Horn.

In a letter already referred to from his wife, it is stated that this species "was found on the banks of the (Columbia) river (in Spokane) now way down town."

Bembidion rickseckeri Hayward.

Hydrophilus rickseckeri (Horn).

Carpophilus rickseckeri Fall.

Hemileuca rickseckeri Watson—Syn. of *H. electra* Wright.

Estigmene rickseckeri (Behr.). now syn. of *E. acræa* (Drury).
form *dubia* (Walker).
Stamnodes rickseckeri Pearsall.

The following interesting notes were furnished by Mrs. Ricksecker:

For the next twenty years (after returning to California from Spokane) Sonoma County was ransacked. At Sylvania [292] the collectors of the California Academy of Sciences made headquarters: Harkness [293] for truffles, Harford for spiders,[294] Rivers for Lepidoptera (and Coleoptera), Mrs. Curran for botany. Then Mr. Ricksecker began to sell and wrote his price lists by hand thereby consuming many hours of meticulous work. His specimens were determined chiefly by Horn and LeConte and at times by Casey.

Fig. 236.—Lucius Edgar Ricksecker (1841–1913), a very successful collector and propagator of western insects. He furnished specimens for many prominent systematists in various fields of natural history. (From a photograph taken in 1906 furnished by Mrs. L. E. Ricksecker.)

After the fire (1906) we went to San Diego and collected all over the country, but found more sale for Lepidoptera, especially moths, though the price list of Coleoptera was rather extensive and now printed by the hundred. We aimed to make expenses and usually did. Wm. Barnes paid a half cent apiece for moths and with a trap of Mr. Ricksecker's invention we often got 1500 a night. We collected caterpillars and raised many adults, mostly *Hemileuca electra* Wright, of which we often had as many as 2000 at a time. The feeding of the larvæ was a task, particularly when it was left to me. Of some butterflies, which were scarce in collections, we found the breeding places and got hundreds. Pupæ were sold in England and other foreign countries, and Coleoptera, before the war, went to a half dozen European countries, but

[292] Here was situated a farm owned by Ricksecker where he lived when not occupied with professional duties. It was a favorite collecting ground located near the present site of Camp Meeker, Sonoma County.

[293] H. W. Harkness was a pioneer botanist and worked mostly on the lower Cryptogams, chiefly fungi. Biographical notice and portrait, *Zoe*, vol. 2, pp. 1–2 (1891).

[294] Rivers also collected some spiders for Geo. W. and Elizabeth G. Peckham.

chiefly to Russia and Germany. The beetles were glued, button fashion, on cards with the catalog numbers and clipped off as ordered. Butterflies were sold in triangles. The passion vine butterfly, or Gulf fritillary, *Dione vanillæ* (Linn.) [295] and the western parsley caterpillar were both introduced into San Diego by Mr. Ricksecker.

Ricksecker often tethered female beetles, like *Prionus*, to a fence with a silk thread in order to capture the males which were thus attracted. Moths were caught in the same manner.

We were collecting at Descano when Mr. Ricksecker had his first stroke and were preparing to go to Kern and Tulare when he had the second which ended all activities. E. C. Van Dyke disposed of the last of the Coleoptera, after the San Diego Society of Natural History had a set of each.

The Ricksecker collection of several thousand specimens of beetles was purchased at a cost of four hundred dollars and donated to the University of California by J. M. McDonald of San Francisco, Matthew Cooke of Sacramento, and Cutter Paige of San Francisco.[296]

This collection did not form a part of his personal collection which was completely destroyed by the fire of 1906. It was purchased in 1881 and was housed in large glass-faced cedar drawers in two walnut cabinets which were made by Ricksecker. According to C. W. Woodworth none of the specimens bore the name of the collector. Some were incorporated in the general collections, but most of them had completely disappeared prior to my arrival at the university in August, 1914. In 1926 Mrs. Ricksecker presented to the California Academy of Sciences 240 specimens of insects.

Riley, Charles Valentine [297] (Fig. 237). Born at Chelsea, England, September 18, 1843; died at Washington, D. C., September

[295] Karl R. Coolidge (*Ent. News*, vol. 35, pp. 22–23, 1924) states that it is "certainly indigenous to the Mohave and Colorado Desert Regions, and as early as 1876 was reported to be very abundant about San Diego." E. C. Van Dyke personally observed it in abundance about Los Angeles in 1885.

[296] Dwinelle, C. H., Calif. State Board of Hort., *Bien. Rept.*, p. 102 (1884).

[297] Strecker, H., *Butterflies and moths of N. Am.*, pp. 263–264 (1878).

Pacific Rural Press, vol. 34, pp. 57, portrait, 65–66 (July 23, 1887).

Meldola, R., et al., *Trans. Entom. Soc. London* (*Proc.*), pp. xxvi–xxx, lxviii–lxix (1895).

Howard, L. O., Philos. Soc. Wash., *Bul. 13*, pp. 412–416 (1895); U. S. Dept. Agr. *Yearbook*, 1899, pp. 140–141, portrait (1900).

Can. Entom., vol. 26, pp. 174–175 (1894); vol. 27, pp. 273–274, portrait (1895).

Entom. News, vol. 6, pp. 241–243, portrait (1895).

Entom. Record and Jour. Var., vol. 7, p. 72 (1895).

Psyche, vol. 7, p. 308 (1895).

M'Lachlan, R., *Entom. Mthly. Mag.*, vol. 31, pp. 269–270 (1895).

Packard, A. S., Entom. Soc. Ontario, *26th Ann. Rept.*, pp. 95–100, portrait (1895); *Science*, n.s., vol. 2, pp. 745–751 (1895).

Howard, L. O., et al., *Proc. Entom. Soc. Wash.*, vol. 3, pp. 293–298, portrait (1896).

Goode, G. B., *Science*, n. s., vol. 3, pp. 217–225 (1896).

14, 1895, from injuries received in a fall from his bicycle. Foremost American economic entomologist, Riley was liberally educated in England, and spent six years abroad, chiefly in France and Germany. In 1860, at the age of seventeen, he came to America and settled on a stock farm in Illinois and soon began to make observations on insects injurious to the crops of that state. Four years later, in 1864, he went to Chicago and began his career in economic entomology as a reporter on the Prairie Farmer. He also spent six months with the 134th Illinois Volunteers in the Civil War. On April 1, 1868, he was appointed State Entomologist of Missouri. During the following nine years he was occupied in the preparation of the Nine Annual Reports on Noxious, Beneficial and other Insects of Missouri for the years 1868–1877. These reports [298] represent one of the greatest pieces of early entomological work ever executed and at once gave Riley an international reputation. In 1868, B. D. Walsh and Riley started the American Entomologist and jointly edited the first volume. On the death of Walsh, Riley became sole editor of volume 2, 1860, and volume 3, 1880.

The U. S. Entomological Commission, consisting of C. V. Riley, A. S. Packard and Cyrus Thomas, was organized in 1877, and issued five reports, the first in 1877, the second in 1880, the third in 1883. Riley issued the fourth in 1885, and Packard the fifth in 1890. He also issued a number of the Bulletins of the Commission during the period from 1877–1881.

In 1878 he was appointed Entomologist to the Department of Agriculture. A contention over salary caused his resignation the following year, but he was reappointed in 1881 and began the great work which resulted in the formation of the Division and later the Bureau of Entomology. One of his greatest gifts was the ability to choose good men and he soon had his work thoroughly and efficiently organized. In 1884, with the aid of L. O. Howard and E. A. Schwarz, he organized the Entomological Society of Washington

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Mayet, V., *Ann. Soc. Entom. France*, vol. 65, pp. 630–640, portrait (1896).
Starr, F., *Pop. Sci. Mthly.*, vol. 52, pp. 640–641, portrait (1898).
Nat. Cyclop. Am. Biogr., vol. 9, pp. 443–444, portrait (1907).
Smith, J. B., *Pop. Sci. Mthly.*, vol. 76, pp. 476–477, portrait (1910).
Walton, W. R., *Proc. Entom. Soc. Wash.*, vol. 23, pp. 92–93 (1921).
Wade, J. S., *Ann. Entom. Soc. Am.*, vol. 21, p. 513 (1928).
Horn, W., and Schenkling, S., *Index Litt. Entom.*, vol. 3, p. 995 (1928); vol. 4, p. 1423 (1929).

[298] Much of the investigation work in these reports was done by Otto Lugger, Theodore Pergande, William Macwitz, and others, who received little or no credit for their efforts.

and on November 12–14, 1889, he founded the Association of Economic Entomologists.[299] He was the first president of each

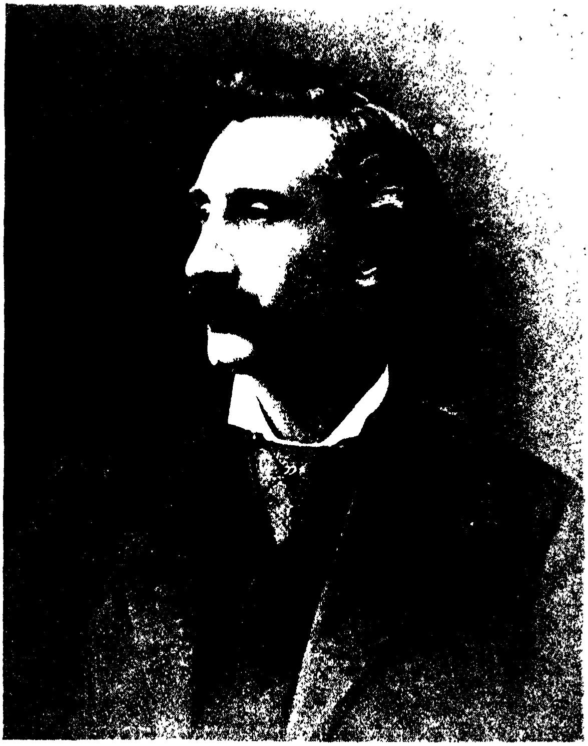

FIG. 237.—Charles Valentine Riley (1843–1895), the organizer of economic entomology in America and one of its greatest exponents. He exerted a tremendous influence upon the development of entomology in this country and probably contributed more separate papers on the subject than any other individual. (From a photograph loaned by Prof. Lawrence Bruner.)

organization. He founded the entomological collections in the U. S. National Museum by donating his own collection of 115,000 specimens of mostly economic insects in 1880, and was appointed Honorary Curator of the Department of Insects. Insect Life, a periodical bulletin of the Division of Entomology, edited by Riley, appeared in July, 1888, and continued under his guidance through volume 6, 1894.[300]

[299] The name of this organization was changed to the American Association of Economic Entomologists in 1909.

[300] The last volume, 7 (1895), was edited by L. O. Howard.

Riley took a prominent part in the introduction of the natural enemies of the cottony cushion scale from Australia into California during the period from 1888 to 1889, being solely responsible for the work of both Albert Kœbele and D. W. Coquillett in this connection. In view of his interest in California, which he visited in 1887, he was elected an honorary member of the California Academy of Sciences, January 3, 1888.

In connection with the terrible ravages of the grape phyloxera in France, Riley suggested the use of the American resistant grape rootstocks and received a gold medal from the French government. " In 1889 he was appointed by the President of the United States an Expert Commissioner to the Paris Exposition and Representative of the Department of Agriculture." For his services in this exposition he received the Cross of the Legion d'Honneur of France. In 1892 he was appointed Biologist of the Maryland Experiment Station. Among other accomplishments of Riley was the invention and development of the cyclone nozzle and kerosene emulsion in connection with the work on scale insects in Florida by H. G. Hubbard in 1880–1885.

In addition to his great contributions in economic entomology, Riley did a considerable amount of systematic work [301] and was an expert entomological draftsman. At the death of the great English entomologist, J. O. Westwood, in 1892, he was a candidate for the Hope Professorship of Zoölogy at Oxford, but was too late in the field to receive the appointment. In May, 1894, he resigned his position as entomologist of the United States Department of Agriculture to devote his entire time to the insect collections of the U. S. National Museum. His death the next year cut short a work that can only be surmised concerning one with so much energy, ability, and determination. He was a member of all the American entomological societies and most of the European societies, including honorary fellowships in the Entomological Society of London and the Royal Agricultural Society of England.

He published 2,418 papers in his own name and 478 papers with B. D. Walsh. One of his addresses of special interest to Californians was given at the State Fruit Growers' Convention at River-

[301] A paper of interest to most entomologists at the time was entitled, *A manual of instructions for collecting and preserving insects*, U. S. Nat. Mus., Bul. 39, 147 pp., 139 figs., 1 pl. (1911). (First issued in 1893.)

side, April 12, 1887, in which he discussed the cottony cushion scale, *Icerya purchasi* Maskell.[302]

Some of the mites and insects of importance named by Riley are:

Six-spotted mite, *Tetranchus 6-maculatus* Riley.
Lesser migratory locust, *Melanoplus atlanis* (Riley).
Elm gall aphis, *Eriosoma americana* (Riley).
Poplar transverse gall aphis, *Pemphigus populitransversus* Riley.
Cabbage looper, *Autographa brassicæ* (Riley).
Apanteles acronyctæ Riley.
kœbelei Riley.
smerinthi Riley.
Meteorus hyphantriæ Riley.
Trichogramma minutum Riley.
Telenomus clisiocampæ Riley.
Ophelosia crawfordi Riley.
Wheat straw worm, *Harmolita grandis* (Riley).
Eridontomerus isosomatis (Riley).

A few of the many insects named for Riley are:

Telamonanthe rileyi Goding.
Phlepsius rileyi Baker.
Icerya rileyi Ckll.
Margarodes rileyi Giard.
Sinea rileyi Montandon.
Rheumatobates rileyi Bergroth.
Mythicomyia rileyi Coq.
Doliosyrphus rileyi Will.
Brachypalpus rileyi Will.
Onychagrotis rileyana Morrison.
Heteropacha rileyana Harvey.
Chalia rileyi Heylærts.
Synanthedon rileyana (Hy. Edwards).
Pterophorus rileyi Fernald.
Ephestia rileyella Ragonot.
Anacampsis rileyella (Chambers).
Pyroderces rileyi (Walsingham).
Bucculatrix rileyi Frey and Boll.
Lithocolletis rileyella Chambers.
Isodyctium rileyi (Cresson).
Apanteles rileyanus Viereck.
Aleiodes rileyi Cresson.
Macrorileya Ashmead (genus of Eurytomidæ).
Rileya Ashmead (genus of Eurytomidæ).
Telenomus rileyi Howard.

[302] Calif. State Board of Hort., *Bien. Rept.*, 1885–1886, pp. 450–462 (1887) [also see pp. 394–397; U. S. Dept. Agr., Div. Entom., *Bul. 15*, pp. 1–26 (1887)].

FIG. 238.—James John Rivers (1824–1913) was a broadly trained biologist, who early became associated with a group of California naturalists known as the Arthrozoic Club (see Fig. 201). He was curator of organic natural history, University of California, from 1881 to 1895, and donated a small collection of insects to the university. (From a photograph taken at Los Angeles in 1878 and furnished by Dr. F. E. Blaisdell. On the back of the original in Rivers' handwriting was the following comment: "This was taken by the desire of the Class of '78 and also Mrs. Rivers was included in the indulgence. This is what I call Insectivorous Rivers." See also Fig. 42.)

Rivers, James John[303] (Figs. 201, 238). Born in Winchester, England, January 6, 1824; died in Santa Monica, California, December 16, 1913, nearly ninety years old. He studied medicine at the University of London and attended the meetings of the Entomological Society of London, and early became acquainted with Thomas H. Huxley, Charles Darwin, Alfred R. Wallace, H. T. Stainton, Robert M'Lachlan, T. Vernon Wollaston, Francis Walker, G. R. Crotch, and others. Under such influences he became a general naturalist with a marked inclination towards entomology. About 1867 he came to the United States, settling first in Kansas about 1870, where he soon became associated with Francis H. Snow, the pioneer entomologist at the University of Kansas. He later spent a short time in Denver, Colorado, and came to California between 1875 and 1880. He immediately associated himself with the California Academy of Sciences and joined the group of naturalists including H. H. Behr, James Behrens, W. G. W. Harford, George W. Dunn and others, known as the Arthrozoic Club. He was curator of Organic Natural History in the University of California until 1895, when he removed to

[303] Grinnell, Fordyce, Jr., *Entom. News*, vol. 25, pp. 143–144 (1914); *Bul. Brooklyn Entom. Soc.*, vol. 9, pp. 72, 73 (1914).
Wade, J. S., *Ann. Entom. Soc. Am.*, vol. 21, p. 513 (1928).

Ocean Park and Santa Monica, California, where he lived until his death.

He collected in many groups of animals and particularly insects, shells, spiders,[304] reptiles, and also plants. Of the insects he described Coleoptera and Lepidoptera, and published a number of papers on each in the Proceedings of the California Academy of Sciences, Zoe, Papilio, American Naturalist, Entomologica Americana, Entomological News, and the Bulletin of the Southern California Academy of Sciences. In the Lepidoptera he was chiefly interested in the genera *Euphydryas*, *Melitæa* and *Malacosoma*. In the Coleoptera he coöperated with Ricksecker in working out the life history of *Pleocoma*, and described a few species of a number of families. He also studied the habits of the California turret building spider.[305]

His collection was sold in Europe—the Cicindelidæ through Walther Horn and the Carabidæ through H. Rœschke to the Museum at Berlin and the rest through G. Kraatz to the Dahlem Entomological Institute at Dahlem, Germany.

The following insects were named by Rivers:

Amblycheila baroni Rivers.
Brennus oreophilus (Rivers) (*Cychrus*).
Pleocoma puncticollis Rivers.
Necydalis barbaræ Rivers.
Bolboceras horni Rivers.

A few insects named for Rivers are:

Euxoa riversi Dyar.
Phausis riversi Leconte.
Zarhipis riversi Horn.
Trimitomerus riversi Horn.
Hypulus riversi (Leconte).

In addition to these insects the California turret building spider, *Atypoides riversi* Cambridge,[306] was named for him.

Sanford, Oliver Nason[307] (Fig. 239). Born in Boston, Massachusetts, September 21, 1847. He was educated in the public schools of Boston and graduated from the Massachusetts Institute

[304] Many of the spiders collected by him were described by Geo. W. and Elizabeth G. Peckham in America and by O. P. Cambridge in England.

[305] *Zoe*, vol. 2, pp. 318–320 (1891).

[306] Cambridge, O. P., London Zoöl. Soc., *Proc.*, p. 355 (June 5, 1883).

[307] The complete biographical sketch and photograph of Sanford were furnished by F. E. Blaisdell.

Gunder, J. D., *Entom. News*, vol. 40, p. 34 (1929).

of Technology in 1870. After graduation he took up the profession of civil engineer, and specialized in railroad construction. He came to San Diego, California, in 1872, where he resided until he removed to San Francisco in 1900. In San Diego County he farmed until 1898 after which he was county surveyor for several years. In San Francisco he was assistant city engineer from 1900 to 1914. He became interested in entomology when a small boy and made a collection of insects in Massachusetts. He took it up more earnestly in San Diego in 1872, through his acquaintance with a Mr. Spencer,[308] who put him in touch with the coleopterists, Henry Ulke, John L. LeConte, and George H. Horn. He amassed a considerable collection of insects which was sold to F. E. Blaisdell in 1891. Sanford gave up entomological work in 1900, but retained some interest in the collection of shells and fossils which he still has. He did not describe any new species and published newspaper articles only and a price list of Coleoptera of northern, southern, and Lower California.

FIG. 239.—Oliver Nason Sanford (1847–), early California entomological collector, who furnished specimens of Coleoptera to Henry Ulke, J. L. LeConte, Geo. H. Horn, and others. (From a photograph furnished by Dr. F. E. Blaisdell.)

Saussure, Henri Louis Frederic de [309] (Fig. 240). Born at Geneva, Switzerland, November 27, 1829; died at Geneva, Febru-

[308] Spencer was a lawyer, school teacher, and entomologist, who taught school at Poway, San Diego County, where Blaisdell first met him in 1873. Spencer later returned East and died of an intestinal ailment.

[309] Hagen, H. A., *Bibliot. Entom.*, vol. 2, pp. 107–108 (1863).
Burr, M., *Entom. Mthly. Mag.*, vol. 42 (2); vol. 16, pp. 119–120 (1905).
Entom. Rec. and Jour. Var., vol. 17, pp. 167–170, portrait (1905).
Bouvier, E L., *Bul. Mus. d'Hist. Nat.*, Paris, vol. 11, pp. 223–225 (1905).
Yung, E., *Arch. Sci. Phys.*, Geneva, vol. 21, pp. 519–534, portrait (1906).

ary 20, 1905. World famous hymenopterist and orthopterist. Saussure received his elementary education at Briquet and his advanced training at the Institute of Fellenberg, Hofwyl. He studied under the famous entomologist François Jules Pictet de la Rive, who directed his attention to insects. The early part of his entomological career was spent in the study of Hymenoptera and the latter part on Orthoptera, his greatest reputation being made with the last named order. He began the study of the solitary wasps, his first paper appearing in Paris in 1852. After several years' study in Paris, where he received the degree of licentiate [310] of the Faculty of Paris, he began his travels in 1854, going first to the West Indies and then to Mexico, and to the United States, where he met Louis Agassiz and other American scientists. He returned to Europe in 1856 with valuable collections of insects, myriapods, crustaceans, birds, and other animals. Aside from his interest in entomology he also studied geology, geography, and ethnology. In 1858 he founded the Geographical Society of Geneva and was president from 1888–1889. For many years he was a member of the committee which managed the Natural History Museum of Geneva. Here he amassed one of the finest collections of Hymenoptera and Orthoptera in the world. In 1872 he was elected an Honorary Fellow of the Entomological Society of London.

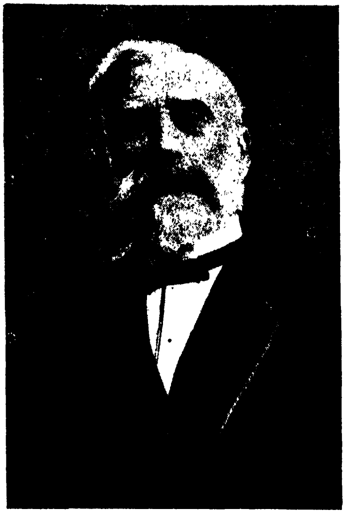

FIG. 240.—Henri Louis Frederic de Saussure (1829–1905), the great Swiss hymenopterist and orthopterist, who named and described many of our most important insects. (From Entom. Record, etc., 1905.)

His most important publications which embrace American insects are:

Monographie des guêpes Solitaires, ou de la tribu des Euméniens, etc. (Paris, Masson, 1852), 286 pp., 22 tabs.

Adelung, N., *Horæ*, Soc. Ent. Ross, vol. 38, pp. x–xix (1907).
Wade, J. S., *Ann. Entom. Soc. Am.*, vol. 21, p. 514 (1928).

[310] He received the degree of Doctor from the University of Gressen in 1850.

Etudes sur la famille des Vespides, Monographie des guêpes sociales ou de la tribu des Vespiens, etc. (Paris, Masson, 1853), 256 pp., 37 pls.

Orthoptera nova Americana, Rev. et Magas. Zool., T. 11, pp. 59–63, 201–212, 315–317, 390–394 (1859); pp. 126–130, 156–164 (1861).

Mémoires pour servir à l'histoire du Mexique, des Antilles et des Etats-unis. 3d part is Orthoptères l'Amérique (Mayenne, 1864); 4th part is Mantides américaines (1871).

Les Fourmis américaines, Bibl. Univ. (3), vol. 10, pp. 28–38, 158–172 (1883).

Orthoptera, in Biologia Centrali-Americana, vol. 1 (1893–1899). *Blattidæ* and *Mantidæ* (with Leo Zehntner), *Gryllidæ,* and *Locustidæ* (with Alphonse Pictet).

Some of our common orthopterous and hymenopterous insects named by Saussure are:

Toltecan grouse locust, *Paratettix toltecus* (Saussure).
Aztec grouse locust, *Telmatettix aztecus* (Saussure).
Pale-winged locust, *Dissosteira spurcata* Saussure.
Behrens' grasshopper, *Conozoa behrensi* Saussure.
Slender Mexican grasshopper, *Leptysma mexicana* (Saussure).
Angular-winged katydid, *Microcentrum rhombifolium* (Saussure).
Mexican katydid, *Scudderia mexicana* (Saussure).
California tree cricket, *Œcanthus californicus* Saussure.
Argentina tree cricket, *Œcanthus argentinus* Saussure.
Consobrine cockroach, *Ischnoptera consobrina* Saussure.
Apache roach, *Arenivaga apacha* (Saussure).
Common yellow jacket, *Vespula diabolica* (Saussure).
Pennsylvania yellow jacket, *Vespula pennsylvanica* (Saussure).
Infernal yellow jacket, *Vespula infernalis* (Saussure).
Sulfur yellow jacket, *Vespula sulphurea* (Saussure).
Golden polistes, *Polistes aurifer* Saussure.
Common polybia, *Mischocyttarus flavitarsis* (Saussure).

Say, Thomas [311] (Figs. 241–243). Born at Philadelphia, Pennsylvania, July 27, 1787; died at New Harmony, Indiana, October 10,

[311] *Am. Jour. Sci.*, vol. 27, pp. 393–395 (1835).
Newman, Edw., *Entom. Mag.*, vol. 2, pp. 536–538 (1835).
Coates, B. H., *Waldies' Select Circ. Library*, vol. 5, pp. 236–239 (1835); *Acad. Nat. Sci.*, Phila., pp. 1–31 (1835); *Nat. Portrait Gallery*, vol. 4, pt. 39, pp. 1–10, portrait (1837).
Swainson, W., *Bibliog. of Zoöl.*, pp. 317–318 (1840).
Morris, J. G., *Am. Jour. Sci. & Arts*, vol. 1, pp. 20–24 (1846).
Binney, W. G., *Complete writings of Thomas Say on the Conchology of U. S.* (New York, Bailliere, 1858), 6+252 pp.
Ord, G., *Am. Entomology by Thos. Say*, edited by J. L. LeConte (New York, Bailliere, 1859), pp. vii–xxii.
Hagen, H. A., *Bibliot. Entom.*, vol. 2, pp. 110–112 (1863).
Am. Jour. Conchology, vol. 1, p. 1, portrait only (1865).
Strecker, H., *Butterflies and Moths of N. Am.*, p. 266 (1878).
Kingsley, J. S., *Pop. Sci. Mthly.*, vol. 21, pp. 577, 687–691, portrait (1882).

1834. The father of American entomology, and the first great systematic entomologist in this country. He was educated in the Quaker schools of Philadelphia and later learned pharmacy under his father, Benjamin Say, who was a physician and apothecary. However, he had no interest in his father's business and gave all of his spare time to collecting and studying objects of natural history. His love of biology was stimulated when he became a member of the Academy of Natural Sciences of Philadelphia in 1812, the year it was founded. Here he came under the influences of a group of enthusiastic naturalists and in 1818 he accompanied Wm. Maclure, T. R. Peale, and Geo. Ord on a collecting trip to the Sea Islands off the coast of Georgia and Florida, which were then in possession of Spain. The hostility of the Indians forced a hasty return. Say was appointed naturalist on Long's Expedition into the far west and visited the Rocky Mountains during 1819–1820, and the sources of St. Peters River, Lake Winnepeg, and Lake of the Woods in 1823. In 1825 he was induced by Wm. Maclure and Robt. Owen

Schwarz, E. A., *Entom. Am.*, vol. 3, p. 60 (1887); *Proc. Entom. Soc. Wash.*, vol. 1, pp. 81–82 (1888).
Dall, W. H., Biol. Soc. Wash., *Proc.*, vol. 4, pp. 98–102 (1888).
Marseul, S. A. de, *L'Abeille*, vol. 26, pp. 265–268 (1889).
Scudder, S. H., *Psyche*, vol. 6, pp. 57–60, 121–124, 137–141, 169–172, 185–187, 297–298, 345–346, 357–358 (1891); vol. 8, pp. 306–307 (1899).
Webster, F. M., *Entom. News*, vol. 6, pp. 1–4, 33–34, 80–81, 101–103, illustrations (1895); *Can. Entom.*, vol. 35, p. 94 (1903).
Youmans, W. J., *Pioneers of Science in America* (N. Y., D. Appleton & Co., 1896), pp. 215–222.
Harris, G. D., *Bul. Am. Paleont.*, vol. 1, no. 5, pp. 2–84, 271–354, portrait (1896).
Harris, T. W., *Psyche*, vol. 8, pp. 399–401, 411–414 (1899).
Fox, W. J., *Entom. News*, vol. 12, pp. 110–113, 138–141, 173–177, 203–205, 233–236, 281–283, 314–316 (1901); vol. 13, pp. 9–11, 38–40 (1902).
Lockwood, G. B., *The New Harmony Communities* (Marion, Ind., 1902); *The New Harmony Movement* (N. Y., D. Appleton & Co., 1907), xvi+404 pp.
Lamb's Biogr. Dict. of U. S., vol. 6, p. 624 (1903).
Howard, L. O., *Can. Entom.*, vol. 35, pp. 138–139 (1903).
Entom. News, vol. 6, p. 45 (1895); vol. 17, p. 248 (1906).
Smith, J. B., *Pop. Sci. Mthly.*, vol. 76, pp. 467–468, portrait (1910).
Moore, Edward E., *A century of Indiana* (New York, 1910).
Dow, R. P., *Bul. Brooklyn Entom. Soc.*, vol. 8, pp. 52–54, 72 (1913).
Owen, C. D., *Seth Way, a romance of New Harmony Community* (New York, 1917).
Haguewood, F. K., *Am. Collector*, vol. 2, p. 366 (1925).
Weiss, H. B., and Ziegler, G. M., *The communism of Thomas Say*, Jour. N. Y. Entom. Soc., vol. 35, pp. 231–239 (1927).
Jordan, David Starr, and Butler, A. W., *New Harmony*, Scientific Mthly., vol. 25, pp. 468–470 (1927).
Horn, W., and Schenkling, S., *Index Litt. Entom.*, vol. 3, pp. 1048–1051 (1928); vol. 4, p. 1425 (1929).
Wade, J. S., *Ann. Entom. Soc. Am.*, vol. 21, pp. 514–515 (1928).
Barber, H. S., *Entom. News*, vol. 39, pp. 15–20 (1928).

to join in the settlement at New Harmony,[312] Indiana, " where the sum of human happiness, it was believed, would be exalted; and where science and letters, it was confidently affirmed, would soon arise, like the orient sun, to enlighten our benighted western world. . . . The confraternity at New Harmony disagreed, quarreled, and separated. Both leaders left. Say, who was resident agent for the whole property, was involved for life, married, and had no means of livelihood except from Maclure. He, therefore, remained. He had a bad stomach (perhaps from dysentery) and was not well. He took fever and died."

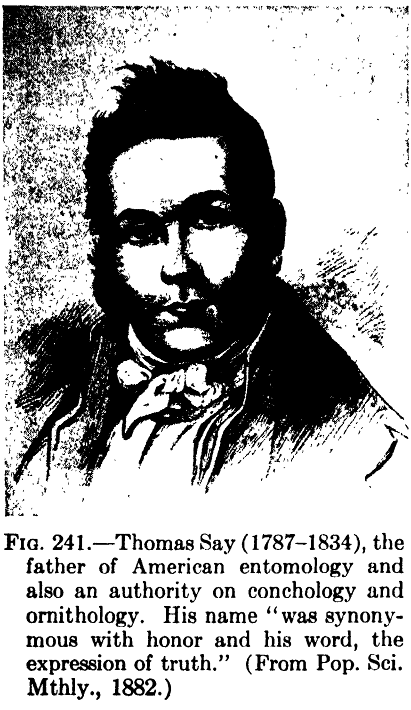

FIG. 241.—Thomas Say (1787–1834), the father of American entomology and also an authority on conchology and ornithology. His name "was synonymous with honor and his word, the expression of truth." (From Pop. Sci. Mthly., 1882.)

Prior to leaving Philadelphia Say had already accomplished much in the study of shells. This work [313] was finished and printed at New Harmony. Mrs. Say[314] drew the plates, but the printing was, indeed, poor. His great work on American Entomology, consisting of three volumes, was published by Samuel Augustus Mitchell, Philadelphia, I, 1817; II, 1825; III, 1828. The first two volumes were finished at Philadelphia. In addition to this work Say published 28 papers which appeared mostly in the Journal of the Academy of Natural Sciences of Philadelphia, the Transactions of the American Philosophical Society, Philadelphia, the Boston

[312] New Harmony was a communistic religious association composed of persons who migrated from Butler County, Pennsylvania, under the leadership of Geo. Rapp in 1815. The members were known as Harmonists or Rappites. The colony was purchased by Robt. Owen in 1824.

[313] *American Conchology*, W. G., Binney. The complete writings of Thomas Say on the Conchology of the United States (N. Y., Bailliers, 1858), pp. 6+252, 75 pls.

[314] Mrs. Say was formerly Lucy May Sistere. She was married to Say in 1827 and lived in the home at New Harmony several years after the death of her husband when she moved to New York to live with her sister, Mrs. Frances Ball. She died at the age of 83.

Journal of Natural History, and those published at New Harmony. All of his entomological writings were collected and edited by the eminent coleopterist, John L. LeConte, in 1859.[315]

Say has been described as slender, six feet in height, modest, and with a lisp in his articulation. His name "was synonymous with

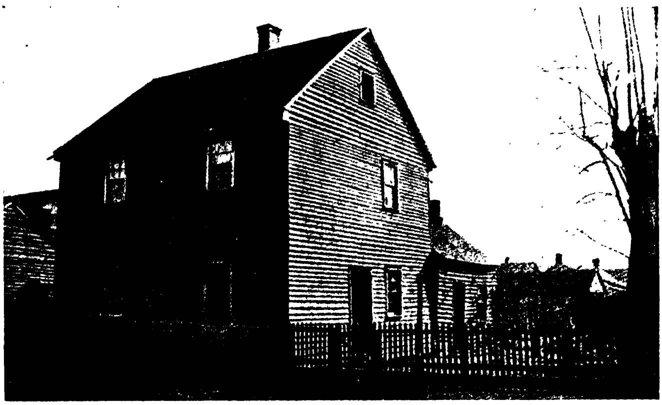

FIG. 242.—The first home of Thomas Say at New Harmony, Indiana, as it appeared a few years prior to 1895. It has since been remodeled and rebuilt. He later acquired the fine house, formerly owned by George Rapp and William Maclure, in which he died. (After F. M. Webster, Entom. News, 1895.)

honor, and his word the expression of truth." He belonged to the Academy of Natural Sciences of Philadelphia and was a foreign member of the Linnean Society of London and the Zoölogical Society of London. As the pioneer worker along the middle Atlantic coast and in the great Ohio and upper Mississippi River valleys, Say named and described many of what have proved to be our most important economic insects such as the Colorado potato beetle, chinch bug, grape leafhopper, Hessian fly, peach tree borer, etc. It is surprising how many of our important species were described by him, as will be seen from the following list:

Two-striped locust, *Melanoplus bivittatus* (Say).
Ceanothus spittlebug, *Clastoptera obtusa* (Say).
Three-cornered alfalfa hopper, *Stictocephala festina* (Say).
Wide-footed treehopper, *Campylenchia latipes* (Say).
Hieroglyphic sharpshooter, *Cicadella hieroglyphica* (Say).

[315] *The complete writings of Thomas Say on the entomology of North America*, edited by John L. LeConte; with a memoir of the author by George Ord (New York, Bailliere, 1859), vol. I, 21+412 pp., 54 col. pls.; vol. II, 4+814 pp., 1 pl.

Sharp-headed grain leafhopper, *Dræculacephala mollipes* (Say).
Grape leafhopper, *Erythroneura comes* (Say).
Oblique leafhopper, *Erythroneura obliqua* (Say).
Black-faced shield bug, *Homæmus æneifrons* (Say).
Alternate shield bug, *Eurygaster alternatus* (Say).
Conchuela, *Chlorochroa ligata* (Say).
Green soldier bug, *Acrosternum hilaris* (Say).
Spined predacious bug, *Podisus maculiventris* (Say).
Reflex plant bug, *Harmostes reflexulus* (Say).
Box elder bug, *Leptocoris trivittatus* (Say).
Mutic stilt bug, *Neides muticus* (Say).
Common milkweed bug, *Lygæus reclivatus* Say.
Chinch bug, *Blissus leucopterus* (Say).
Common water strider, *Gerris remigis* Say.
Undulate back swimmer, *Notonecta undulata* Say.
Pruinose leather-winged beetle, *Podabrus tomentosus* (Say).
Two-spotted collops, *Collops bipunctatus* Say.
Striped collops, *Collops vittatus* (Say).
Spotted blister beetle, *Epicauta maculata* (Say).
Confluent buprestid, *Buprestis confluenta* Say.
Common carrion dermestid, *Dermestes marmoratus* Say.
Undulate ladybird, *Hyperaspis undulata* (Say).
Small ashy-gray ladybird, *Psyllobora viginti-maculata* (Say).
Western blood-red ladybird beetle, *Cycloneda munda* (Say).
Ashy-gray ladybird beetle, *Olla abdominalis* (Say).
Grain seed beetle, *Embaphion muricatum* (Say).
Ten-lined June beetle, *Polyphylla decemlineata* (Say).
Black pine sawyer, *Monochamus scutellatus* (Say).
Colorado potato beetle, *Leptinotarsa decemlineata* (Say).
Alder flea beetle, *Haltica bimarginata* Say.
Five-striped willow beetle, *Disonycha quinquevittata* (Say).
Banded flea beetle, *Systena tæniata* (Say).
Bean weevil, *Mylabris obtectus* (Say).
Potato stalk borer, *Trichobaris trinotata* (Say).
House mosquito, *Culex quinquefasciatus* Say.
Woodland malaria mosquito, *Anopheles punctipennis* (Say).
Hessian fly, *Phytophaga destructor* (Say).
Oblique syrphid, *Allograpta obliqua* (Say).
Geminate syrphid, *Mesogramma geminata* (Say).
Cactus syrphid, *Copestylum marginatum* (Say).
Peach tree borer, *Ægeria exitiosa* Say
Microbracon hebetor (Say).
Hyposoter fugitivus (Say).
Ophion bilineatus Say.
Enicospilus purgatus (Say).
Itoplectis conquisitor (Say).
Merisus destructor (Say).
Ovate chalcid, *Brachymeria ovata* (Say).

Thief ant, *Solenopsis molesta* (Say).
Acrobat ant, *Cremastogaster lineolata* (Say).
Odorous ant, *Tapinoma sessile* (Say).
Honey ant, *Prenolepis imparis* (Say).
Pacific cuckoo wasp, *Holochrysis pacifica* (Say).
Common tarantula hawk, *Pepsis formosa* Say.
Emarginate leaf cutting bee, *Anthidium emarginatum* (Say).

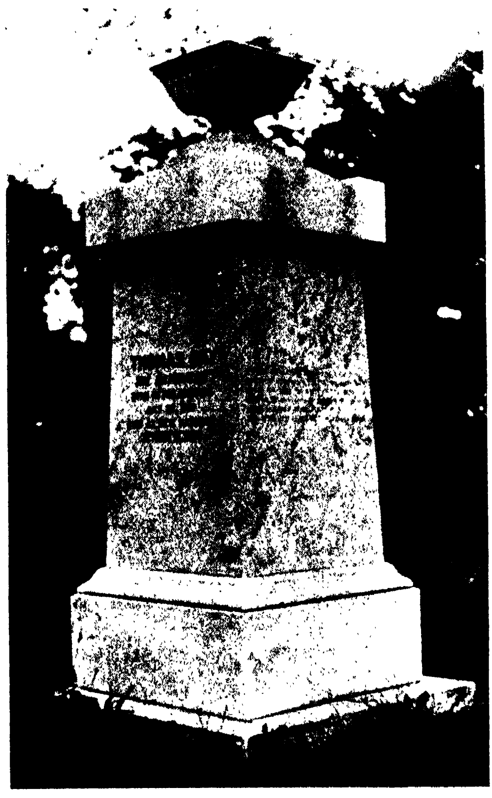

Fig. 243.—Thomas Say is one of the very few American naturalists whose grave is marked by a monument. This honor was not accorded to him either by an admiring nation or a benefited posterity. The monument of white marble, about six feet high, was erected by Alexander Maclure in the name of his deceased brother, William, in 1846. (Photograph furnished by F. C. Hottes in 1929. It must have been taken a number of years previous, for Dr. Hottes informs me that the inscription of verse, here shown, was nearly obliterated on his visit there in 1929.)

Say's collection was a matter of considerable controversy and passed from the Academy of Natural Sciences of Philadelphia to the Museum of Comparative Zoölogy at Cambridge, Mass., and

back again. It was much neglected, with the result that it was almost completely destroyed by dermestid beetles. Some of his species of Coleoptera are represented in the Melsheimer Collection at Cambridge.

Say has named a number of important birds which occur in California, such as the western kingbird, *Tyrannus verticalis* Say, California linnet, *Carpodacus mexicanus* (Say), lazuli bunting, *Passerina amœna* (Say), cliff swallow, *Petrochelidon lunifrons lunifrons* (Say), the orange-crowned warbler, *Vermivora celata celata* (Say), and the long-billed dowitcher, *Macrorhamphus griseus scolopaceus* (Say). A bird named for him is the Say phœbe, *Sayornis sayus* (Bonaparte).

FIG. 244.—Eugene Amandus Schwarz (1844–1928), veteran member of the U. S. Bureau of Entomology, a specialist in Coleoptera, and honorary president of the Entomological Society of Washington, of which he was one of the founders. (From L. O. Howard et al., 1928.)

Schwarz, Eugene Amandus [316] (Fig. 244). Born in Liegnitz, Silesia, Prussia, April 21, 1844; died in Washington, D. C., October 15, 1928, at the age of eighty-four years and six months, after having been a member of the Bureau of Entomology for more than fifty years. He was educated at Liegnitz Gymnasium, University of Breslau, and the University of Leipzig. He received the degree of Sc. D. from the University of Maryland in 1923. He came to the United States in December, 1872, and received a position in the Museum of Comparative Zoölogy (Cambridge) as preparator with G. R. Crotch under H. A. Hagen, 1873–1875. He attended the lectures of Agassiz and Hagen during his stay there, which ended at the death of the former and the financial embarrassment of the institution. Afterwards he accompanied his friend and pupil H. G.

[316] Howard, L. O., Barber, H. S., Busck, A., *Proc. Entom. Soc. Wash.*, vol. 30, pp. 153–183, portrait, pl. 7 (1928).
Horn, Walther, *Entom. Mittheilungen*, vol. 17, no. 5 (Sept. 20, 1928).

Hubbard to Detroit where they founded the Detroit Scientific Association and formed the beginnings of the great Hubbard-Schwarz collection of Coleoptera. Many collecting trips were made in the interests of this collection first to Florida and then in the Great Lakes region.

At the meetings of the American Association for the Advancement of Science at Detroit, August, 1875, Schwarz met Lintner, Riley, Grote, Osten Sacken, William Saunders, J. L. LeConte and others and formed friendships which determined much of his after life. During the winter of 1876 he was employed to determine the George D. Smith collection of Coleoptera in Detroit, Michigan. In May, 1878, he went to Colorado to collect beetles for John L. LeConte and was summoned to Washington by C. V. Riley in June of the same year for entomological employment in the U. S. Department of Agriculture and the newly formed Division of Entomology where he remained until retired in 1926, except two years spent with Riley and the U. S. Entomological Commission during the period of 1879–1881, when Comstock was entomologist for the Department of Agriculture. The first problem undertaken was the investigation of the cotton worm in Texas, other southern states, and the Bahamas. Following later introductions of the blastophaga into California by the Bureau of Entomology in 1899, Schwarz made some studies of the insect in relation to Smyrna fig culture in 1900 [317] in the orchards of George C. Roeding at Fresno, California. At the time of his death Schwarz was one of the few remaining entomologists who early worked with such men as L. Agassiz, H. A. Hagen, J. L. LeConte, George H. Horn, C. V. Riley, H. G. Hubbard, Albert Kœbele, and others. He was one of the founders of the Entomological Society of Washington in 1884 and was made an Honorary President for life in 1916.

He was also one of the first Honorary Fellows of the Entomological Society of America and the first Honorary Member of the Entomological Society of New York.

He devoted most of his time to the systematic study of Coleoptera in which order he amassed a large collection in the U. S. National Museum where he was made Custodian of Coleoptera in 1898. He wrote 395 papers in various periodicals, but chiefly in the American Entomologist, American Naturalist, Bulletin of the

[317] Schwarz, E. A., *A season's experience with figs and fig-insects in California*, Proc. Entom. Soc. Wash., vol. 4, pp. 502–507 (1901).

Brooklyn Entomological Society, Proceedings of the Entomological Society of Washington, and Insect Life. His first paper appeared in 1870 [318] and the last in 1926.[319] Schwarz also described a few species of Chermidæ (Homoptera), and before leaving Germany, had published some short papers on beetles.

The following are, perhaps, among the most important papers written by him:

Coleoptera of Florida (with LeConte, J. L.), Proc. Am. Philos. Soc., vol. 17, pp. 353–472 (1876).

An enumeration of the published synopses, catalogues, and lists of North American insects; together with other information intended to assist the student of American entomology, U. S. Dept. Agr., Div. Entom. Bul. ser. 1, no. 19, 77 pp. (1888).

North American publications on entomology, Proc. Entom. Soc. Wash., vol. 2, pp. 5–23 (1891).

Preliminary remarks on the insect fauna of the Great Salt Lake, Utah, Can. Entom., vol. 23, pp. 233–241 (1891).

Coleoptera of the Harriman Alaska Expedition, Wash. Acad. Sci., vol. 2, pp. 523–537 (1900).

The San Francisco disaster, Proc. Entom. Soc. Wash., vol. 8, p. 100 (1907).

Collecting Coleoptera, U. S. Nat. Mus., Bul. 39, pt. F, pp. 43–50 (1893); Bul. 67, pp. 76–86 (1909).

Some Western insects named for him are:

Thammotettix schwarzi Ball.
Aphlara schwarzi Ashm
Crophius schwarzi Van Duzee.
Camptobrochis schwarzi (Uhler).
Philophorus schwarzi Reuter
Cossonus schwarzi Van Dyke.
Pissodes schwarzi Hopk.
Lasconotus schwarzi Kraus.
Tachydromia schwarzi Coq.
Ænigmatias schwarzi Coq.

Scudder, Samuel Hubbard [320] (Fig. 245). Born at Boston, Massachusetts, April 13, 1837; died at Cambridge, Massachusetts,

[318] *Über seine in Begleitung des Herru von Rattenberg nach dem Glatzer Schneeberg unternommene Excursion*, Jahresbericht der Schlesischen Ges. für Natürliche Kultur, vol. 47, pp. 180–199 (1869).

[319] *Condition of the coleopterous collection of the National Museum in 1906*, Proc. Entom. Soc., Wash., vol. 28, pp. 71–86 (1926).

[320] Dimmock, G., *Dimmock's Special Bibliog.*, no. 3, pp. 1–28 (1879).
Benjamin, M., *Harper's Weekly*, vol. 34, pp. 925–926, portrait (1890).
Nat. Cyclop. Am. Biog., vol. 3, pp. 99–100 (1893).
Smith, J. B., *Pop. Sci. Mthly.*, vol. 76, pp. 473–474, portrait (1910).
Appalachia, vol. 12, pp. 213, 276–279, portrait (1911).
Bethune, C. J. S., *Can. Entom.*, vol. 43, pp. 253–254 (1911).

May 17, 1911. Because of his great fundamental work in insect paleontology and in the orders Orthoptera and Lepidoptera, Scudder is to be regarded as one of the greatest systematic entomologists so far produced in America. During his educational training at Williams College, from which he graduated at the head of his class in 1857,[321] he came under the influence of the noted geologist, Ebenezer Emmons, and the naturalist, Albert Hopkins. He finished his studies with Louis Agassiz and received a B. S. degree in 1866, and became assistant to the great zoölogist in 1864. At about the same time he was also appointed custodian of the Boston Society of Natural History. Both of these positions were relinquished in 1870 to take up scientific work more fully. He became assistant librarian of Harvard University in 1879, a position he held until 1882.

FIG. 245.—Samuel Hubbard Scudder (1837–1911) is to be regarded as one of the greatest systematic entomologists so far produced in America and as the founder of insect paleontology in this country. He was a leading specialist in the orders Orthoptera and Lepidoptera and described many insects in each. (From Psyche, 1911.)

He was one of the founders of the Cambridge Entomological Club in 1874 and was not only the founder of Psyche but editor from 1883–1885, and president of the Boston Society of Natural

Cockerell, T. D. A., *Science*, n. s., vol. 34, pp. 338–342 (1911).
Entom. Record, vol. 23, pp. 255–256 (1911).
Entom. News, vol. 22, pp. 224, 288, 289–292, pl. viii, portrait (1911).
Kingsley, J. S., et al., *Psyche*, vol. 18, pp. 175–192, portrait (1911).
Am. Jour. Sci. (4), vol. 31, p. 582 (1911).
Holland, W. J., et al., *Ann. Entom. Soc. Am.*, vol. 5, p. 72, portrait (1912).
Mayor, A. G., *Mem. Nat. Acad. Sci.*, vol. 17, pp. 81–104, portrait, complete bibliography (1924).
Wade, J. S., *Ann. Entom. Soc. Am.*, vol. 21, p. 515 (1928).
Horn, W., and Schenkling, S., *Index Litt. Entom.*, vol. 4, pp. 1106–1107 (1929).

[321] Williams College supplemented the degree of A. B. with an A. M. in 1860 and D.Sc. in 1890. The Western University of Pennsylvania gave him the degree of LL.D. in 1890.

History [322] from 1882–1887. From 1886–1892 he was paleontologist of the U. S. Geological Survey and it was during this period that he laid the foundations for the study of fossil insects and became the greatest American authority of insect paleontology. The immensity of this contribution may be conjectured when one knows that from the appearance of his first paper in 1865 until 1890 he described 838 Tertiary insects of North America. These were largely from Florissant, Colorado. He also named eighty species of beetles from Postpliocene and Interglacial deposits of Canada and three from Massachusetts as well as nearly two hundred species of Paleozoic insects. In 1891 he published the Index to the Known Fossil Insects of the World, including Myriapods and Arachnids, U. S. Geol. Surv., Bul. 71, 744 pp.

His work on the Orthoptera began in 1862 and continued unabated until 1900 and during that period, and for many years afterwards, he was considered America's foremost authority in this order. His first paper [323] included the descriptions of 115 new species. Other important papers appeared as follows:

Catalogue of the Orthoptera of North America described previous to 1867, Smithsonian Misc. Coll., 110 pp. (1868).

Stridulation of Orthoptera, Entom. Soc. Ontario (1893).

Guide to the genera and classification of the North American Orthoptera found north of Mexico (Cambridge, Mass., 1897), bibliography.

Revision of the Orthoptera group Melanopli (Acridiidæ with special reference to North American forms), U. S. Nat. Mus., Proc., vol. 20, pp. 1–421, pls. i–xxvi (1897).

Index to North American Orthoptera, Boston Soc. Nat. Hist., Occas. Papers, 6, complete bibliography (1901).

Catalogue of described Orthoptera of U. S. and Canada, Davenport Acad. Nat. Sci. (Davenport, Ia.), Proc., vol. 3, pp. 1–101, pls. i–iii (1900).

The Orthopteran group Scudderiæ, Am. Acad. Arts and Sci., Proc., vol. 33 (15), pp. 271–290, 1 pl. (1908).

In addition to the above he published one paper on exotic Orthoptera which contained 122 foreign species.[324]

His work on the Lepidoptera began in 1889 when he issued the great work on the Butterflies of the Eastern United States and

[322] He was recording secretary 1862–1870, librarian 1864–1870, custodian 1864–1865, 1866–1870, vice president 1874–1880. In 1898 he received the Walker Prize of one thousand dollars from this society.

[323] *Materials for a monograph of North American Orthoptera, including catalogue of New England species* (1862).

[324] *List of exotic Orthoptera*, Boston Soc. Nat. Hist., Proc., vol. 27, pp. 201–218 (1868–1869).

Canada in three large volumes. This is still a standard and most useful contribution. Several minor papers on butterflies followed, ending in 1893 with The Life of a Butterfly.

It will be seen that these three distinct lines of work were pursued at much the same time and all overlapped at the end. In addition to these specialized fields he published the Catalogue of Scientific Serials in 1879,[325] and the Nomenclator Zoölogicus in 1882.[326] The latter was an enormous task and included a list of the genera used in Zoölogy to 1880.

He was one of the organizers of the Appalachian Mountain Club, the Boston Naturalists Club, editor of Science from 1883 to 1885, general secretary of the American Association for the Advancement of Science in 1875, and vice-president in 1894. His greatest efforts were on behalf of the Cambridge Entomological Club which he fathered as long as he had the physical energy to do so. He was a member of the National Academy of Sciences, American Philosophical Society, American Academy of Arts and Sciences, New York Academy of Sciences, Philadelphia Academy of Sciences, Davenport Academy of Sciences, Microscopical Society of Boston, Entomological Society of Washington, Troy Scientific Association, honorary fellow Royal Society of Canada, fellow Entomological Society of London, and a corresponding member of many foreign entomological and zoölogical societies.

He published in all 791 scientific papers.

He never visited the West, but he has described so many of our common species that his name is as familiar to every entomologist in the West as it is throughout the entire country.

Concerning him Mayor writes:

> Far more he was than the most learned entomologist of his generation, for few men of science have endeared themselves to those around them as did he, endowed as he was with an innate quality of kindliness that seemingly unknown to him graced his every word and act. One recalls his tall handsome form and the strong interesting features so wonderfully relieved by the happy soul that seemed ever ready to burst forth in a bright flash of interest over any and all things of that manifold nature to the observation of which his life had been devoted.

He named a great many Western Orthoptera and a few Lepidoptera, some of which are:

[325] *Catalogue of scientific serials of all countries including the transactions of learned societies, in the natural, physical, and mathematical sciences, 1663–1876*, Harvard Univ. Library, Special Pub. no. 1, 12+358 pp. (1879).

[326] U. S. Nat. Mus., *Bul. 19*, 19+376+340 pp. (1882).

Green desert grasshopper, *Orphulella compta* Scudder.
Yellow-winged or pellucid grasshopper, *Camula pellucida* (Scudder).
Giant lubber grasshopper, *Agymnastus ingens* (Scudder).
Green valley grasshopper, *Schistocerca venusta* Scudder.
Vagrant grasshopper, *Schistocerca vaga* (Scudder).
Devastating grasshopper, *Melanoplus devastator* Scudder.
Valley grasshopper, *Œdaleonotus enigma* (Scudder).
Bruner's shield bearer, *Capnobotes bruneri* Scudder.
Valley cricket, *Clinopleura melanopleura* (Scudder).
Yellow camel cricket, *Tropidischia xanthostoma* Scudder.
California camel cricket, *Ceuthophilus californianus* Scudder.
Pictured sand cricket, *Stenopelmatus pictus* Scudder.
Minute mole cricket, *Ellipes minuta* (Scudder).
California timema, *Timema californica* Scudder.
Minor mantid, *Litaneutria minor* (Scudder).
Northern dusky wing, *Cocceius pylades* (Scudder).
Gray skipper, *Pyrgus tessellata* Scudder.

Selys-Longchamps, Michel Edmond de[327] (Fig. 246). Born at Paris, May 25, 1813; died at Luttich, Belgium, December 11, 1900. He was a man of wealth and rank, and although he never studied at a university he was a person of great political influence and became the greatest known world authority in the study of dragonflies or Odonata, although he was also interested in other neuropteroid and orthopteroid insects. He was also a great European authority in Ornithology and wrote many papers on birds. In public life he was a representative of various communities in the Belgium parliament and later became a senator and for a time President of the Senate. In entomology he was the father of the study of Odonata and was in part responsible for the work of his able successors, H. A. Hagen and Robert M'Lachlan. His wealth and influence enabled him to amass one of the great-

[327] Hagen, H. A., *Bibliot. Entom.*, vol. 2, pp. 150–152 (1863).
Verrall, G. H., *Proc. Entom. Soc. London*, p. xlv (1900).
Lameere, A., *Ann. Soc. Entom. Belg.*, vol. 44, pp. 467–472 (1900); *Mem. Soc. Entom. Belg.*, vol. 9, pp. 1–32, portrait (1902).
Lucas, W. J., *Entomologist*, vol. 34, p. 32 (1901).
M'Lachlan, R., *Entom. Mthly. Mag.*, vol. 37, pp. 78–80 (1901).
Calvert, P. P., *Entom. News*, vol. 12, pp. 33–37, 158, portrait (1901).
Entom. Record and Jour. Var., vol. 13, pp. 79–80, portrait (1901).
Ris, F., *Mittheil. Schweiz. Entom. Ges.*, vol. 10, pp. 367–369, 1897–1903 (1901).
Blasius, R., *Jour. Ornith.* (5), vol. 8, pp. 361–381, portrait (1901).
Plateau, F., *Ann. Acad. Belg.*, vol. 68, 117 pp., portrait (1901).
Dubois, A., and Martin, C. H., *Bul. Soc. Zoöl. France*, pp. 24–29, portrait (1901).
Kruger, L., *Stett. Entom. Zeit.*, vol. 62, pp. 214–217 (1901).
Camerano, *Atti Accad. Torino*, vol. 36, pp. 327–334 (1902).
Wade, J. S., *Ann. Entom. Soc. Am.*, vol. 21, p. 515 (1928).
Horn, W., and Schenkling, S., *Index Litt. Entom.*, vol. 4, pp. 1111–1113 (1929).

est collections of Neuroptera and Orthoptera (in their broadest terms) in the world. It included the insects of these two large groups brought together by P. A. Latreille, J. P. Rambur,[328] J. G. Audinet-Serville, and F. E. Guêrin-Mèneville, and is deposited in the Belgium National Museum.

In all he contributed some two hundred and fifty articles, some of which were fundamental in nature and are of interest to entomologists the world over. These are:

FIG. 246.—Baron Michel Edmond de Selys-Longchamps (1813–1900), Belgian political official and world authority on the dragonflies and damselflies of the order Odonata. His wealth and influence enabled him to amass one of the finest collections of neuropteroid insects in the world and to describe species from many lands. (From R. Blasius, Jour. für Ornithologie, 1901.)

First Period (1831–1851). Exclusive European species.

Monographie des Libellulidées d'Europe (Paris, Roret, 1840), 220 pp., 4 tab.

Revue des Odonates ou Libellules d'Europe (with Hagen, H. A.), Mem. Soc. Sc. Liége, T. 6, pp. xxii+408, tab. 11, tabellen 6 (1850).

Second Period (1853–1886). Monographic revisions of world species.

Monographie des Colopterygaines (with Hagen, H. A.), *ibid.*, T. 9, xi–291 pp., 14 tab. (1854).

Catalogue des insectes Lépidoptères de la Belgique, Ann. Soc. Entom. Belg., T. 1, pp. 1–111, 176–177, (1857).

Monographie des Gomphines (with Hagen, H. A.), Mem. Soc. Sc. Liége, T. 11, pp. 257–720, 23 pls., 5 tab. (1858).

Synopsis des Agrionines, Bul. Acad. Bruxell (2) Five parts (1860–1865) (never completed).

Third Period (1857–1891). World faunal papers.

Memoirs of Odonata from New Guinea, Philippines, Japan, Palæarctic Regions, Europe, Sumatra, and Burma (1878–1891).

[328] J. P. Rambur named the following California dragonflies: *Gomphoides obscura* (Rambur), *Gynacantha trifida* Rambur and *G. nervosa* Rambur. *Hist. Naturelle des insectes*, Neuroptères (Suites à Buffon) (Paris, Roret, 1842), vol. 8, 17–535 pp., 12 col. pls

Selys-Longchamps named a considerable number of American neuropteroid insects as shown by the following list:

Lestes disjunctus Selys.
Enallagma robustum Selys.
semicirculare Selys.
Zoniagrion exclamations (Selys).
Ischnura cervula Selys.
perparva Selys.
ramburi Selys.
Tanypteryx hageni (Selys).
Ophiogomphus bison Selys.
morrisoni Selys.
Gomphus sobrinus Selys.
Tetragoneuria spinigera Selys.
Leucorrhinia hudsonica (Selys).

FIG. 247.—Victor Antoine Signoret (1816–1889), a distinguished French entomologist and one of the first great coccidologists. (After L. Fairmaire, 1889.)

Signoret, Victor Antoine [329] (Fig. 247). Born in Paris, April 6, 1816; died in the same city, April 3, 1889. He was one of the most distinguished homopterists and hemipterists and one of the first great workers on Coccidæ. His first paper appeared in 1847 [330] and in all he published eighty different articles, some of which are of great importance, such as:

Revue iconographique des Tettigonides, Ann. Soc. Entom. France (3), vol. 1, pp. 13–40, 323–374, 661–688, 8 col. pls. (1853); vol. 2, pp. 5–28, 341–366, 483–496, 717–732, 6 col. pls. (1854); vol. 3, pp. 49–60, 225–240, 507–528, 765–836, 5 col. pls. (1855).

Monographie du genre Corizus, *ibid.* (3), vol. 7, pp. 75–105 (1859).

Essai sur les cochenilles (Coccidæ), *ibid.* (4), vol. 37, pp. 503–528, 829–876 (1868); vol. 38, pp. 97–108, 109–138 (1869); vol. 39, pp. 91–110, 267–286 (1870);

[329] Hagen, H. A., *Bibliot. Entom.*, vol. 2, pp. 164–165 (1863).
Fairmaire, L., *Ann. Soc. Entom. France* (6), vol. 9, pp. 505–512, portrait (1889).
Bul. Soc. Entom. France, pp. 68–69 (1889).
Entom. Mthly. Mag., vol. 25, p. 309 (1889).
Distant, W. L., *Entomologist*, vol. 22, p. 144 (1889).
Wade, J. S., *Ann. Entom. Soc. Am.*, vol. 21, p. 516 (1928).
Horn, W., and Schenkling, S., *Index Litt. Entom.*, vol. 4, pp. 1132–1134 (1929).

[330] *Description de deux Hémiptères-Homoptères, tribu des octicelles, groupe des Cicadides*, Ann. Soc. Entom. France, vol. 16, pp. 293–296 (1847).

vol. 40, pp. 421-434 (1871); vol. 41, pp. 33-46 (1872); vol. 42, pp. 27-47, 395-448 (1873); vol. 43, pp. 87-106, 545-558 (1874); vol. 44, pp. 15-40, 305-394 (1875); vol. 45, pp. 591-676 (1876). (Contains index to all above papers.)

Notice sur quelques faits noveaux, se rapportant à l'histoire du Phylloxera vastatrix, *ibid.*, Bul., vol. 39, pp. lxxiii-lxxvi (1870); vol. 40, pp. xiii, xxv, lxxx-lxxxi (1871); vol. 42, pp. lxxviii-lxxxiii, cxxxix, cxl, clxv (1873); vol. 43, p. ccxxix (1874); vol. 45, pp. lxxvii-lxxviii (1876).

Revision du groupe des Cydnides, ibid., vol. 50, pp. 25-52, 193-218, 319-332, 423-436 (1881); vol. 51, pp. 23-42, 145-168, 241-266, 465-484 (1882); vol. 52, pp. 33-60, 207-220, 357-374, 517-534 (1883); vol. 53, pp. 45-62, 117-128 (index) (1884).

He was a member of the Entomological Society of France, 1843, and an honorary fellow of the Entomological Society of London, 1882.

Among the common species of insects named by him are:

Tessellated palm scale, *Eucalymnatus tessellatus* (Sign.).
Mediterranean fig scale, *Lepidosaphes ficus* (Sign.).
Aspidistra scale, *Pinnaspis aspidistræ* (Sign.).
Greedy scale, *Aspidiotus camelliæ* Sign.

His collection is in the museum at Vienna.

Stål, Carl [331] (Fig. 248). Born at the Castle of Carlberg, Sweden, March 21, 1833; died at Trösundavik, near Stockholm, June 13, 1878. He was the greatest Swedish hemipterist and orthopterist, and one of the greatest hemipterists in the world. He was a student at Upsala in 1853, passed the medico-philosophical examination in 1858, then studied anatomy and physiology at Stockholm, and later took a Ph. D. at Jena. In 1859 he became assistant to the great Swedish coleopterist, C. H. Boheman, in the Entomological Section of the National Zoölogical Museum at Stockholm, and after the death of Boheman he was appointed

[331] Hagen, H. A., *Bibliot. Entom.*, vol. 2, pp. 188-189 (1863).
Distant, W. L., *Entom. Mthly. Mag.*, vol. 15, pp. 78-79, 94-96, 191-192 (1878). Ins. Translvaaliensis, p. 197, portrait (1907).
Signoret, V. A., *Ann. Soc. Entom. France* (5), vol. 8, pp. 177-186 (1878).
Pet. Nouv. Entom., vol. 2, no. 200, p. 247 (1878).
Entom. Nachr., vol. 4, pp. 260-261 (1878).
Bolivar, I., *Ann. Soc. Espan. Hist. Nat.*, vol. 7, pp. 59-61 (1878).
Horvath, G., *Termes. Füzet*, vol. 2, pp. 210-212 (1878).
Mittheil. Schweiz. Entom. Ges., vol. 5, pp. 388-391 (1878).
Bates, H. W., *Proc. Entom. Soc. London*, p. lxii (1878).
Reuter, O. M., *Entom. Mthly. Mag.*, vol. 15, pp. 72, 94-96 (1878).
Spangberg, J., *Stett. Entom. Zeit.*, vol. 40, pp. 97-105 (1879).
Wade, J. S., *Ann. Entom. Soc. Am.*, vol. 21, p. 517 (1928).
Horn, W., and Schenkling, S., *Index Litt. Entom.*, vol. 3, pp. 1174-1176 (1929).

professor and superintendent of the section in 1867. He made many trips throughout Sweden and in Europe and studied in many of the museums and particularly the one at Kiel where he studied and published on the Fabrician species of Hemiptera.[382]

Fig. 248.—Carl Stål (1833–1878), the great Swedish hemipterist and orthopterist and one of the greatest hemipterists of the world. He named and described many of the important insects from this country and his name is familiar to all entomologists. (From a print furnished by Prof. C. F. Baker.)

Although he specialized most in Hemiptera, he was also a great worker in Orthoptera as well as in Coleoptera and Hymenoptera. He did a great deal of fundamental, systematic, and taxonomic work and named and described many important insects from this country. His most valuable contributions are:

Hemiptera, Kongl. Svensky Freggattens Eugenies resa omkring Jorden, 1851–1853 (Stockholm, Norstedt & Söner, 1858), 4 Insecter III, pp. 219–298, Tab. 2. (Some insects were taken by the naturalists on the ship *Eugenie* in California and described by Stål, while Boheman described the Coleoptera.)

Till Kännedomen af Phytophaga, Öfvers Kongl. Vet. Acad. Föhrhandl., vol. 14, pp. 53–63 (1857).

Till Kännedomen om Amerikas Chrysomeliner, *ibid.*, vol. 15, pp. 469–478 (1858).

Beitrag zur Hemipteren-Fauna Sibiriens und des Russichen Nord-Amerika, Stett. Entom. Zeit., vol. 19, pp. 175–198, pl. I (1858).

Monographie des Chrysomelides de l'Amerique, Nova Acta Regia Societatis Scientiarum Upsalensis (3), vol. 4, pp. 1–86 (1862); II, pp. 87–176 (1863); III, pp. 177–365 (1865).

Hemiptera Africana, (Holmiæ, 1864–1866), 275 pp., 1 pl.

Enumeratio Hemipterorum, (Stockholm, Norstedt & Söner, 1870–1876), 162 pp.

Recensio Orthopterorum, vols. 1 to 3 (1873–1876).

His collection is in the National Museum of Stockholm.

Some of the important Western insects named by Stål are the following:

[382] *Hemiptera Fabriciana*, K. Vet. Akad. Förhadl., vol. I (1868); vol. 2 (1869).

Red-wing locust, *Dissosteira venusta* (Stål).
Pale treehopper, *Ceresa albido-sparsa* Stål.
Western corsair, *Rasahus thoracicus* Stål.
Say's plant bug, *Chlorochroa sayi* Stål.
Green plant bug, *Chlorochroa uhleri* Stål.
Brown cotton bug, *Euschistus impictiventris* Stål.
California false chinch bug, *Nysius californicus* Stål.
Big-eyed bug, *Geocoris pallens* Stål.
Bordered plant bug, *Euryophthalmus convivus* (Stål).
Arizona cotton stainer, *Dysdercus albidiventris* Stål.
Western water creeper, *Ambrysus signoreti* Stål.
Fiery tarantula hawk, *Pepsis mildei* Stål.

Stretch, Richard Harper[333] (Fig. 249). Born at Nantwich, England, November 25, 1837; died at the home of his daughter, Mrs. William Hainsworth, 2657 Thirty-seventh Avenue Southwest, Seattle, Washington, March 22, 1926. He was educated in Quaker schools in England and became interested in natural history as a small boy. He held the position as a draper's apprentice, 1853–1859; and as cashier in a manufacturing company, 1860. In 1861 he visited his uncle at Adrian, Illinois, and collected insects at Panama and New Orleans en route. After a month's stay and visits to Philadelphia and Washington, he returned to England and devoted his time to architecture and building, but only to come again to America in 1863. In that year he joined an emigrant party bound for California and stopped at Virginia City, Nevada, where, after a time in a land office, he was elected state mineralogist of Nevada in 1886.[334] By close application to study he became an authority in mining and civil engineering. When he finally arrived in California in 1867, "he introduced the method of making squares on maps, marked A, B, C and 1, 2, 3, etc., now used the world over." After a visit to San Francisco and Chihuahua, Mexico, he again went toVirginia City during the winter of 1868–1869 to study the Comstock Lode for the U. S. Geological Survey. A few years after returning to San Francisco, he became city surveyor in 1870. In 1874 he visited his old home in England and upon his return to California spent two years, 1875–1876, at

[333] Coolidge, Karl R., and Newcomb, H. H., *Entom. News*, vol. 31, pp. 181–185, portrait (1920).
Pan-Pacific Entom., vol. 2, p. 160 (1926).
Wade, J. S., *Ann. Entom. Soc. Am.*, vol. 21, p. 517 (1928).
Seattle Post Intelligencer, p. 8 (March 23, 1926).
[334] *Ann. Rept. State Mineralogist Nevada*, 1866, 151 pp. (1867).

Havilah, Kern County. While there he is credited with having sunk the first artesian well in California near Fresno, and for putting in the headgate for the first large irrigation ditch in the state near Kingsbury. All these years he was collecting Lepidoptera and devoting his spare hours to the study of moths belonging to the families Zygænidæ and Bombycidæ. His first article on *Neophasia menapia* (Felder)[335] appeared in 1882 and many other short articles followed in various entomological periodicals. His greatest contribution on the Zygænidæ and Bombycidæ[336] was prepared during the years 1872–1873. His drawings are particularly fine, as are shown in this work; and some of them were published in 1906.[337] In connection with his entomological work he early became associated with the California Academy of Sciences as a resident member, November 18, 1867, and was the first to give an extended account of the newly introduced cottony cushion scale, *Icerya purchasi* Mask., taken at Menlo Park, before that body on September 16, 1872. In referring to this incident later he stated: "This warning was utterly disregarded, when if appreciated it would have saved millions, as I pointed out what might be the

FIG. 249.—Richard Harper Stretch (1837–1926), engineer and entomologist. He was the first to call attention officially to the presence of the cottony cushion scale in California in 1872. Stretch was specially interested in the saturnid, euchromid, and arctiid moths, of which he described a number. (From a photograph loaned by Dr. F. E. Blaisdell, 1927.)

[335] *Notes on* Pieris menapia *Felder*, Papilio, vol. 2, pp. 103–110, pl. 2 (1882).

[336] *Illustrations of the Zygænidæ and Bombycidæ of North America* (San Francisco, 1874), 242 pp., 10 pls.

[337] *Heterocera Americana*, Jour. N. Y. Entom. Soc., vol. 14, pp. 117–125, pls. ii–xii (1906).

result of inaction to prevent spread."[338] He was intimately acquainted with the well-known lepidopterists, A. R. Grote, H. H. Behr, Henry Edwards, S. H. Scudder, William H. Edwards, and others. Of these his closest friend was Henry Edwards. Following the death of his wife in 1885 he donated his entomological library to the Mechanics' Institute in San Francisco and his collection of Lepidoptera to the University of California.[339]

In 1888 he moved to Seattle, Washington, and for many years lived at 2657 Thirty-seventh Avenue, S. W. After the death of Henry Edwards in 1891 he lost his interest in insects and devoted the remainder of his life to engineering work in the Northwest. "He laid out West Seattle, was chief engineer of the Seattle and Southern Railroad, and also, in later years, spent some time at Skaguay, Alaska, as engineer for the White Pass and Yukon Railroad." He wrote a textbook on mining engineering that had a wide use throughout the country.[340]

In addition to the articles already cited, the following should also be listed:

Report upon new species of Zygænidæ and Bombycidæ collected in portions of California and Arizona during the years 1871, 1872, 1873, U. S. Geol. Surv. west of 100 m., Rept., 1875–89, vol. 5, pp. 795–802 (1875).

Notes on the genus Clisiocampa, Papilio, vol. 1, pp. 63–69 (1881); vol. 3, pp. 19–20 (1883).

Descriptions of new species of Heterocera, Entom. Am., vol. 1, pp. 101–107 (1885).

The colias controversy, Can. Entom., vol. 18, pp. 54–56 (1886).

The more important moths named by Stretch are:

Nevada buck-moth, *Hemileuca nevadensis* Stretch.
Brown ctenucha, *Ctenucha brunnea* Stretch.

[338] Coolidge and Newcomb, *op. cit.*, p. 185 (1920).

[339] When I came to the University of California in August, 1914, the Stretch Collection was in the attic of Agriculture Hall. It was housed in a walnut cabinet consisting of two rows of drawers, or forty in all, each drawer 18 × 22 in. made of redwood, with close-fitting glass cover. There were two glass doors to the cabinet. The specimens, consisting largely of moths were neatly spread and arranged in rows. Most of the North American species were correctly labeled, but many of the brightly colored exotics were without name or locality labels. The collection at this time was badly infested with the buffalo carpet beetle, *Anthrenus scrophulariæ* (Linn.). It was thoroughly fumigated by the writer and later in 1915 by E. P. Van Duzee. In 1919 the entire collection was transferred by Van Duzee as a loan to the California Academy of Sciences where it is now housed in new insect-proof containers. The collection was never as large as estimated by Coolidge and Newcomb, 13,000, but contained more nearly 5,000 specimens.

[340] *Prospecting, locating, and valuing mines, A practical treatise for the use of prospector investors, and mining men generally* (N. Y. and London, Scientific Pub. Co., 1899), 381 pp., 15 pls. (ed. 2, 1900).

Clemensia lactea Stretch.
Eubaphe costata Stretch.
Leptarctia Stretch (Genus).
Neoarctia yarrowi Stretch.
Diacrisia latipennis Stretch.
Estigmene albida Stretch.
Apantesis intermedia Stretch.
bolanderi Stretch.
Kodiosoma Stretch (Genus).
fulva Stretch.
Androloma brannani Stretch.
Oak tent caterpillar, *Malacosoma constricta* (Stretch).
Great basin tent caterpillar, *Malacosoma fragilis* (Stretch).

A few insects bearing his name are:

Polia stretchi (Hy. Edw.).
Catocala stretchi Behr.
Syneda stretchi Behr.
Melissodes stretchi Cress.

Terloot de Popelaire,[341] **A. J. Grayson, T. L. Mead,**[342] and **Samuel Brannan** [343] collected various insects in Mariposa County.

Thomas, Cyrus [344] (Fig. 250). Born at Kingsport, Tennessee, July 27, 1825; died at Washington, D. C., June 27, 1910. One of the foremost early systematic and economic entomologists. A lawyer and Lutheran minister who became entomologist and botanist of the Geol. Survey of Territories under Hayden in 1869–1873. He later became a teacher of natural sciences at the Illinois State Normal School from 1874–1876 and was appointed State Entomologist of Illinois in 1875. He was for five years a member of the U. S. Entomological Commission with A. S. Packard and C. V. Riley. His Third Annual Report of the State Entomologist of

[341] The Terloot's butterfly, *Neophasia terlooti* Behr (spelled *terlooii* by Behr) was collected by him in the pine forests of the Sierra Madre in Arizona. *Lepisesia terlooti* Hy. Edwards, occurs in Mexico and Georgia.
[342] Mead also collected extensively in Colorado and Arizona. There are at least ten species and varieties of Lepidoptera named for him by A. S. Packard, W. H. Edwards, A. R. Grote, Henry Edwards, and H. K. Morrison.
[343] The Agaristid moth, *Androloma brannani* Stretch, is named for him.
[344] Goding, F. W., *Ill. Hort. Soc.*, vol. 22, pp. 106–108 (1888).
Nat. Cyclop. Am. Biog., vol. 13, pp. 528–529 (1906).
Forbes, S. A., *Jour. Econ. Entom.*, vol. 3, pp. 383–384 (1910).
Rehn, J. A. G., *Entom. News*, vol. 21, pp. 387–388 (1910).
Wade, J. S., *Ann. Entom. Soc. Am.*, vol. 21, p. 517 (1928).
Horn, W., and Schenkling, S., *Index Litt. Entom.*, vol. 4, p. 1219 (1929).

Illinois on Noxious and Beneficial Insects, 1879, contained the first comprehensive toxonomic study of the homopterous family, *Aphididæ*, published in America [345] and formed the basis for all future work of the family in this country. In 1873 he published the Synposis of the Acridiidæ of North America [346] which was his most important paper. In addition to his contributions to the reports of the U. S. Entomological Commission, he published twenty-eight papers.

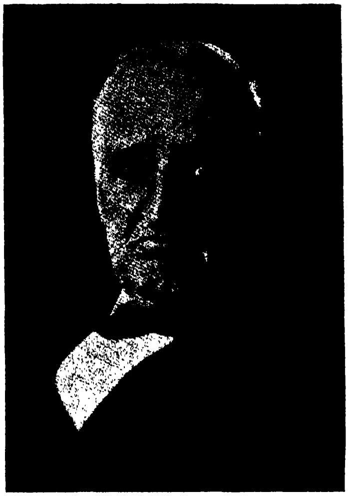

FIG. 250.—Cyrus Thomas (1825–1910), lawyer, minister, entomologist, and ethnologist, was one of the foremost early systematic and economic entomologists in America. He was a member of the U. S. Entomological Commission and State Entomologist of Illinois and is chiefly known for his work on Aphididæ and Acridiidæ. (From a print furnished by Dr. L. O. Howard.)

He named chiefly Acridiidæ of the Orthoptera, and Aphididæ in the Homoptera, and the following of his long list of new species are of interest to the West:

Elliott's grasshopper, *Aulocara elliotti* Thomas.

Long-winged locust, *Dissosteira longipennis* (Thomas).

Large green bush grasshopper, *Schistocerca shoshone* (Thomas).

Differential grasshopper, *Melanoplus differentialis* (Thomas).

Western locust, *Melanoplus occidentalis* (Thomas).

Western shield bearer, *Cynobotes occidentalis* (Thomas).

Coulee cricket, *Peranabrus scabricollis* (Thomas).

Tree camel cricket, *Gammarotettix bilobatus* (Thomas).

Banded sand cricket, *Stenopelmatus fasciatus* Thomas.

Maple aphis, *Drepanaphis acerifolii* Thomas.

Box elder aphis, *Periphyllus negundinis* (Thomas).

Cloudy-winged cottonwood aphis, *Periphyllus populicola* (Thomas).

Aster root aphis, *Anuraphis middletoni* (Thomas).

Rusty plum aphis, *Hysteroneura setariæ* (Thomas).

Pumpkin aphis, *Illinoia cucurbitæ* (Thomas).

Ambrosia aphis, *Macrosiphum ambrosiæ* (Thomas).

[345] Pages 5–212. Asa Fitch first studied the family in America, but outside of naming a number of new species, he contributed little to the general knowledge of the family.

[346] *Hayden's Rept. U. S. Geol. Surv. Terr.*, vol. 5, pp. 1–258 (1872).

The last twenty-five years of his life were devoted entirely to archæological and ethnological work, during which time he became a recognized authority on the Cherokee and Shawnee Indians and the Maya inscriptions and codices.

His collection, consisting of a few scattered types, is in the U. S. National Museum, Washington, D. C.

Tschernikh (Tschernich, Tschernik). It has been impossible for me to find a published account of Tschernikh. He was a member of the Russian American Company and collected insects both at Sitka and Ross. We first note him at Ross during the time of Wrangell, 1833–1835. One of the large ranches cultivated by the Russians was called Tschernikh.[347] Mannerheim states that he was *Gartnerleben* and probably had charge of the farming operations at Ross and lived at and farmed the ranch bearing his name. This ranch was known as Gorgy's Ranch and as Don Jorge's Rancho (by the Spanish) and was located about five miles north of Bodega Bay. It is related that Don Jorge was a scientist and a man of ability and that he remained some time after the Russians. I am unable to find out whether Tschernikh and Don Jorge are one and the same person as appears possible. That he did not stay long is evidenced by the fact that his ranch was included in the sale to Sutter and is mentioned as one of the pieces of property left "intact in possession of the Company's agents" as guarantees for payment. The agents remained to look after the interests of the Company. Tschernikh was at Ross in 1841 and accompanied Vosnesensky to the top of Mount St. Helena on June 12, 1841. He collected extensively at Sitka and Ross, taking chiefly Coleoptera which was very largely described by Mannerheim.[348]

[347] The three ranches were named (Kostromitinof) (Kostromitinov), Khlébnikoff (Khlébnikof), and Tschernikh (Gorgy's). According to Bancroft [History of Calif., vol. IV, p. 638 (1886)], the last had two thousand vines when turned over to Capt. John Sutter in 1841. Kiryll Khlébnikoff held a prominent position in the company and wrote many important letters. "I find no record in the Russian authorities giving Khlébnikof's residence at Fort Ross for any length of time. In Tikhmenief's history, p. 343, there is a statement that Khlébnikof was sent to California in 1831 to investigate prices of commodities then prevailing in California. In his own writing Khlébnikof mentions that he was at Fort Ross in 1820 on the ship *Buldakoff* when he delivered 100 varieties of fruit trees to Fort Ross. They were apple, pear, cherry and peach. These trees were procured from Monterey. Khlébnikof was the chief accountant and the Commissary of the company and lived at Sitka. There is a stone lying on the road going to the Indian River at Sitka with his initials carved, said to be done by his own hand. They are: 'K, XЛ, 1832.' X is the sound for Kh. and the character is L."—Rev. A. R. Kashevaroff.

[348] *Beitrag zur Käfer-Fauna der Aleutischen Inseln, der Insel Sitka und Neu-Californiens*, Bul. Nat. Hist. Moscow (1843). Suppl. in 1846, 1852, 1853.

His name was given to the interesting bombardier beetle, *Brachinus tschernikhi* Mann., which he collected. Other interesting beetles taken by him in California are:

Pterostichus vicinus Mann. (Also taken by Blaschke.)
Elaphrus riparius Linn. (*E. californicus* Mann.)
Chlænius vicinus Dejean.
The hairy rove beetle, *Creophilus maxillosus* (Linn.) var. *villosus* (Grav.).
Cardiophorus californicus Mann. (Also taken by Blaschke.)
Black burying beetle, *Necrophorus pustulatus* Herschel var. *nigritus* Mann.
Silpha lapponica Hbst. (*S. californica* Mann.)
The Western twelve-spotted cucumber beetle, *Diabrotica soror* Leconte, was taken by Eschscholtz in 1824 and again by Tschernikh. Russian entomologists confused it with *D. duodecempunctata* (Fabr.).
The Western striped cucumber beetle, *Diabrotica trivittata* Mann.
Rugose stag beetle, *Sinodendron rugosum* Mann.
Dentate eleodes, *Eleodes dentipes* Esch. (Also taken by Eschscholtz and Blaschke.)
Margined eleodes, *Eleodes marginata* Esch. (Also taken by Eschscholtz and Fischer.)
The grand eleodes, *Eleodes grandicollis* Mann. (Also taken by Wrangell.)
Helops californicus Mann. (Also taken by Eschscholtz.)
Coniontis eschscholtzi Mann. (Also taken by Eschscholtz and Fischer.)
Haltica californica (Mann.) (*Graptodera*).
Microrhopala rubrolineata (Mann.) (*Odontota*).
Cibdelis blaschkei Mann. (Also taken by Blaschke.)
These specimens collected by Tschernikh were taken about Fort Ross and between there and Bodega Bay and Mount St. Helena.

Uhler, Philip Reese [349] (Fig. 251). Born at Baltimore, Md., June 3, 1835; died at Baltimore, October 21, 1913. America's greatest hemipterist. Uhler was the son of a prominent merchant in Baltimore and had the advantage of a good education in private schools. At an early age he came under the influences of Rev. J. G. Morris and J. F. Wild, who were responsible for his interest and subsequent training in entomology. When placed in his father's business in 1856, he spent most of his time on natural history. In 1864 he was appointed by Louis Agassiz to take charge of the insects in the Museum of Comparative Zoölogy and the library at Cambridge, Mass., and during this period he made collecting trips

[349] *Nat. Cyclop. Am. Biog.*, vol. 8, p. 251 (1900).
Henshaw, S., *Psyche*, vol. 10, pp. 31–42, 85–92, 122–124, 224–238 (1903). Bibliography.
Howard, L. O., *Entom. News*, vol. 24, pp. 433–439, portrait (1913).
Schwarz, E. A., et al., *Proc. Entom. Soc. Wash.*, vol. 16, pp. 1–7, portrait (1914).
Wade, J. S., *Ann. Entom. Soc. Am.*, vol. 21, p. 518 (1928).
Horn, W., and Schenkling, S., *Index Litt. Entom.*, vol. 4, p. 1246 (1929).

to Hayti, West Indies, and his own state of Maryland. In 1867 he relinquished his position at Harvard, which was filled by the appointment of H. A. Hagen, and returned to Baltimore to become assistant librarian to J. G. Morris at Peabody Institute. He became librarian in 1870 and provost from 1880 to 1911. He perfected the cataloguing in the library there and gave all of his spare time to the study of Homoptera and Hemiptera. In 1888, a trip to Europe to purchase books for the Institute, gave him an opportunity to study insects in the European collections and upon his return to America he became the leading authority in his field. Failing eyesight forced him to give up technical work in 1890 and he gave his splendid collection to the U. S. National Museum. Some types are in the States of Colorado, Kansas, and California.[350] The European Hemiptera, Orthoptera, and Odonata are at the Museum of Comparative Zoölogy at Cambridge, Mass., and the West Indian types are in the British Museum at London.

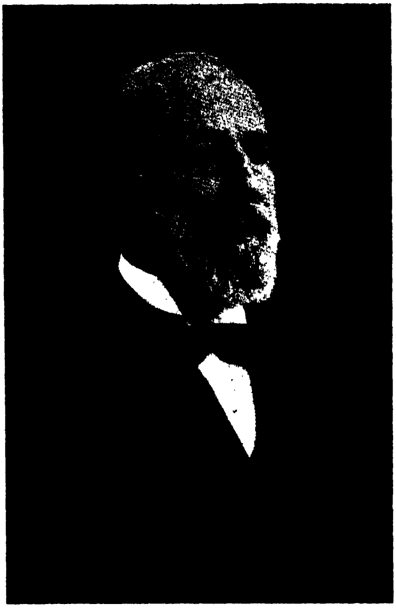

FIG. 251.—Philip Reese Uhler (1835–1913), America's foremost hemipterist. He described many species of Hemiptera and Homoptera from all parts of the country. (After L. O. Howard, Entom. News, 1913.)

His first works were purely economic, but his most important papers, of which there are sixty-nine, were largely on Hemiptera and Homoptera, although he also studied and published on Orthoptera, Coleoptera and Neuroptera. He translated H. A. Hagen's Synopsis of N. Am. Neuroptera from Latin to English.

He described many species of Homoptera and Hemiptera taken from the Western states by the exploring expedition of Rodgers and Ringgold, the northwestern boundary survey, the Hayden surveys

[350] In California Academy of Sciences. The E. P. Van Duzee collection of Hemiptera and Homoptera, also at the same place, contains a wealth of material determined and verified by Uhler.

and from many private collectors in this region. The papers which are of special interest to Western entomologists are:

Hemiptera of the North Pacific exploring expedition under Comr's Rodgers and Ringgold, Acad. Nat. Sci. Phila., Proc., pp. 221–231 (1861). Homoptera from same, *ibid.*, pp. 282–284.

Notices of the Hemiptera of the western territories of the United States, chiefly from the surveys of Dr. F. V. Hayden, U. S. Geol. Surv., Montana, Rept., pp. 392–423 (1872).

Rept. upon collections of Hemiptera made in portions of Nevada, Utah, California, Colorado, New Mexico, and Arizona, during the years 1871–1873 and 1874, U. S. Geol. & Geog. Surv., Rept., vol. 5, pp. 829–842, pls. 42 (1875).

List of Hemiptera of the region west of the Mississippi River, including those collected during the Hayden explorations of 1873, U. S. Geol. & Geog. Surv., Bul., vol. 1, pp. 269–361, pls. 19–21 (1876); *Ibid.*, vol. 3, pp. 355–475, 765–801, pls. 27–28 (1877). (Contains monographs of the families Cydnidæ and Saldidæ.)

Hemiptera, Standard Natural History, vol. 2, pp. 204–296 (1884). [Riverside Nat. Hist., vol. 2, pp. 204–296 (1888).]

Check list of the Hemiptera, Heteroptera of North America, Brooklyn, 34 pp. (1886).

Hemiptera, Heteroptera of the Death Valley Expedition, N. Am. Fauna, no. 7, pp. 260–265 (1893).

Observations upon the Heteropterous Hemiptera of Lower California, with descriptions of new species, Calif. Acad. Sci., Proc. (2), vol. 4, pp. 223–295 (1894).

Some of the interesting Western species which he named are:

Knife mole cricket, *Gryllotalpa cultiger* Uhler.
Girdled cicada, *Tibicen cinctifera* (Uhler).
Bloody cicada, *Okanagana cruentifera* (Uhler).
Red-winged grass cicada, *Tibicinoides cupreosparsus* (Uhler).
Orchard cicada, *Platypedia areolata* (Uhler).
Minor cicada, *Platypedia minor* (Uhler).
Rhubarb spittlebug, *Aphrophora permutata* Uhler.
Destructive leafhopper, *Euscelis exitiosus* (Uhler).
Pallid scolops, *Scolops pallidus* Uhler.
Common negro bug, *Thyreocoris extensus* (Uhler).
Consperse stink bug, *Euschistus conspersus* Uhler.
Apple lacebug, *Corythucha cælata* Uhler.
California Christmas berry tingid, *Corythucha incurvata* Uhler.
Western blood-sucking cone-nose, *Triatoma protracta* (Uhler).
Leafhopper assassin bug, *Zelus socius* Uhler.
American veliid, *Microvelia americana* (Uhler).
Black and white water boatman, *Notonecta shooteri* Uhler.

There are twenty-four valid species of Homoptera and Hemiptera bearing Uhler's name. The green plantbug, *Chlorochroa uhleri* Stål, is one of our commonest shield bugs.

Vosler, Everett Jay [351] (Fig. 252). Born at Fort Collins, Colorado, July 13, 1890; died from pneumonia following influenza, at Fort Rosecrans, San Diego, California, November 7, 1918. He graduated from the Colorado Agricultural College with the degree of B. S. in 1911 and immediately entered the services of the Bureau of Entomology, U. S. Department of Agriculture, as an expert in alfalfa weevil investigations at Salt Lake City, Utah, where he became associated with H. S. Smith in the study and propagation of the parasites of this pest. In 1913 he was chosen as assistant superintendent of the California State Insectary by Smith. He was an expert in handling parasites and became of great value in assisting in this work. In September, 1914, he was appointed by Cook as Secretary of the State Commission of Horticulture, and editor of the Monthly Bulletin, which position he held until he was sent on a collecting expedition to Australia in January, 1917, to search for natural enemies of the beet leafhopper, *Euttetix tenellus* (Baker). Finding his primary object of little avail there and with a mind to the needs of California, he sent over the famous parasite of the half-grown black scale, *Metaphycus lounsburyi* (Howard), which was successfully established in California by Smith, and which for several years did remarkable work in reducing the black scale in the coastal areas of southern California. Upon his return to California in 1918, he joined the 25th

FIG. 252.—Everett Jay Vosler (1890–1918), was one of the most promising of the younger generation of entomologists. He was assistant superintendent of the California State Insectary and sent the black scale parasite, *Metaphycus lounsburyi* (Howard), from Australia to California in 1917. (From a photograph taken in 1917 and loaned by his mother, Mrs. Florence E. Vosler, residing at Sacramento.)

[351] Smith, H. S., Calif. State Com. Hort., *Mthly. Bul.*, vol. 7, no. 10, frontispiece, portrait (1918).
Calif. Citrograph, vol. 4, p. 36, portrait (December, 1918).

Field Artillery, Battery B, and was in training when his untimely death cut short his brief and successful career.

The following articles were contributed by him:

A new fruit and truck crop pest, Calif. State Com. Hort., Mthly. Bul., vol. 2, pp. 551–553, figs. 331–332 (1913).

A new parasite of the black scale, *ibid.*, pp. 661–662 (1913).

The red-humped caterpillar, *ibid.*, pp. 654–657, figs. 363–364 (1913).

Zebra caterpillar, *ibid.*, pp. 713–715, figs. 381–383 (1913).

Recent importation of beneficial insects into California, *ibid.*, p. 770 (1913).

Calliephialtes in California (with Smith, H. S.), *ibid.*, vol. 3, pp. 195–211, figs. 57–71 (1914).

Fruit exhibits at the Royal Easter Show, Sydney, New South Wales, *ibid.*, vol. 6, pp. 235–237 (1917).

Some work of the Insectary Division in connection with the attempted introduction of natural enemies of the beet leafhopper, *ibid.*, vol. 8, pp. 231–239, figs. 95–103 (1919).

Some observations on citrus culture in Australia, Calif. Citrograph, vol. 3, p. 295 (October, 1918).

Vosnesensky, Ilya Gavrilovich [352] (Fig. 253). Naturalist and conserver of the Zoölogical Museum of the Academy of Natural Sciences, St. Petersburg. He made a special trip to the Russian-American colonies in 1839–1840 for the purpose of collecting insects for the Academy and arrived at Ross, July 20, 1840, and remained until September 3, 1841. He was a very successful collector and made a large collection of insects from the San Francisco Bay region, particularly at Ross, Russian River, Bodega Bay, and New Helvetia (Sutter's Fort). He also collected insects in the Caucasus Mountains of Southern Russia, at Kenai Peninsula, Alaska in 1839, Sitka in 1840, Kodiak Island in 1842, both sides of Bering Strait in 1844, Aleutian Island of Atha in 1845, near the region of Nome, Alaska, in 1845, Northern Japan (Kurile Islands) and Commander Islands in 1846, Eastern coast of Siberia in 1847, and Kamchatka in 1848.[353] These trips covered a period of ten years. The specimens taken by him were described by many Russians,

[352] Schmidt, P., *The Pacific Russian scientific investigations*, Acad. Sci., U. S. S. R., pp. 45, 47, 139–140, 168, portrait opp. p. 120 (1926) (Voznesenski). Also spelled Vosnesenski, Wosnesensky, Wossnesensky, and Wosnessensky.

[353] Motschulsky, V. I., *Reisen und Forschungen im Amur-Lande*, 1854–1856, **Band II, p. 79 and chart (1860). In this work Motschulsky uses the spelling Vosnesensky.**

but chiefly by Motschulsky,[354] Ménétriés,[355] and Mannerheim.[356] Vosnesensky collected in many orders and his name is known to all California entomologists in connection with our commonest bumblebee, the yellow-faced bumblebee, *Bremus vosnesenskii* Rad.[357] He also collected the flying pansy or California dog-face butterfly, *Zerene eurydice* Bdv., which long went under the name of *Zerene vosnesenski* Ménétriés in California, and *Parnassius eversmanni* Mén. (*P. vosnesenski* Mén.) in Alaska. Among other important insects taken by him are:

Polycesta californica Mén. At Ross.
Chrysobothris subcylindrica Mén. At New Helvetia.
Monocrepidius hirsutulus Mén. At Ross.
Limonius infuscatus Mén. At New Helvetia.
Limonius maculicollis Mén. At San Francisco.
California prionus, *Prionus californicus* Mots. At Ross.
California laurel borer, *Rosalia funebris* Mots. At Ross.

His collection of insects taken in Caucasus, Kamchatka, and America are in the Museum of the Academy of Leningrad (St. Petersburg).

Vosnesensky, however, is best known in California for having, on June 12, 1841, first climbed and named Mount St. Helena, 4,343 feet high, which is the most conspicuous mountain in the vicinity of Ross. On this trip he was accompanied by Tschernikh.

In commemoration of the 100th anniversary of the birth of Vosnesensky, K. K. Gilsen [358] published in Russian, a very complete sketch of his life and works. Vosnesensky's contributions to the sciences of the Pacific regions are sufficiently important to warrant a translation [359] of Gilsen's paper which is given herewith in full.

Ilya Gavrilovich Vosnesensky (1816–1871).[360] An outline of the life and works of the oldest fellow of the Museums of the Academy.

[354] *Coléoptères Nouveaux de la Californie*, Bul. Imp. Univ. Moscow, T. 32, P. 2, pp. 122–185, 357–410 (1859). Chiefly Coleoptera taken at Fort Ross and New Helvetia.

[355] *Sur un envoi d'insectes de la Côte N. O. d'Amérique*, Bul. Acad. St. Petersb. T. 5, pp. 262–265 (1844).

[356] See Mannerheim bibliography, pp. 699–700.

[357] Radoschkowski, Octavius (Radoshkovski), Col. of Artillery, St. Petersburg, *Bul. Soc. Nat. Moscow*, vol. 35, n. 13, p. 589, T. 6, fig. 1 (1862).

[358] *Pub. Peter the Great Mus. Anthrop. and Ethnol.*, Imp. Mus. Sci., Petrograd, vol. 3, pp. 1–14, portrait (1916).

[359] Translated for me by V. P. Sokoloff, University of California, Berkeley, March 20, 1929.

[360] Brandt, *Bericht über die Reise des Prparanten des Zoölogischen Museums Vosnesenski aus brieflichen Mitteilungen an den Akademiker Dr. Brandt*, Bul. Scientifique publié par l'Académie Imperiale des Sciences de St. Petersburg, T. vii (1840); columns 365–367.

The North-American division of the Museum of Anthropology and Ethnology at the Imperial Academy of Sciences, remarkable for its rich collections of ethnological articles, is inseparably bound with I. G. Vosnesensky who indefatigably and with great knowledge of the subject, working with most scanty means, made these collections, in the course of ten years, among the inhabitants of our former North-American possessions—Eskimos, Alets, and Indians of various tribes. His collections are a monument of great value to the civilization of these nations which have almost disappeared now since the possessions were ceded by the Government of Russia to the United States in 1867.

A special work on the subject of the collections of I. G. Vosnesensky is in preparation for the print. Thus, a worthy tribute shall be paid at last to his service to the science of entomology and to the Museum in particular, on the 100th anniversary of his birthday.

The personality of I. G.,[361] the life and work of this remarkable man, to whom all museums of the Academy are greatly indebted, is a matter of interest by itself. Let this brief sketch of the life of I. G., of his works and labors for the sake of Science, revive on the eve of his 100th birthday the wonderful character and personality of this man and remind us of his invaluable services to the Academy.

I. G. Vosnesensky was born July 19th, 1816, in St. Petersburg. The son of a non-commissioned officer, he, according to Strauch, "received an elementary education corresponding to the social standing of his parents."

In 1821, being five years of age, Vosnesensky started as an apprentice-boy in the printing shop of the Academy of Sciences, and in 1827, having shown an

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Aquisitions du Musée Zoölogique dues au voyage du préparateur Vossnesensky, rapport de M. Brandt, Bul. de la Classe, Phys.-Math. de l'Académie des Sciences, T. v, col. 383–384 (1847).

An outline of history of the Imperial Academy of Sciences by T. T. Brandt, F. J. Ruprecht, and A. F. Gebel (1865).

A. Strauch, *Zoölogical Museum of the Imperial Academy of Sciences—Fifty years of its existence*, App. to vol. 41 of the Proc. of the Imperial Acad. of Sciences, no. 3 (1889).

I. P. Borodin, *Collectionists and Collections of the Siberian Flora*, St. Petersburg (1908).

Administration Committee of the Imperial Academy of Sciences, *The Record of the Offices of the Curator of the Zoölogical Museum, I. G. Vosnesensky, from 1839 on.*

D. I. Litvinov, *Bibliography on Siberian Flora*, St. Petersbourg (1909).

Proceedings of the Conferences of the Imperial Academy of Sciences, 1839, 1840, 1842–1850.

Miscellaneous papers concerning I. G. Vosnesensky in the Archives of the Conferences of the Imperial Academy of Sciences.

Photograph portrait of I. G. Vosnesensky, autographed, marked "1866," belonging to P. A. Perschetsky, his colleague.

Collection of sketches and drawings by I. G. Vosnesensky, Museum of Anthropology and Ethnology at the Imperial Academy of Sciences.

I wish to express my gratitude to P. A. Perschetsky for his courtesy in supplying me with most valuable information concerning I. G. Vosnesensky, and to B. L. Modsalevsky who made it possible for me to utilise considerable biographic material.

[361] "I. G." wherever it occurs in the text is equivalent to the complete name of Vosnesensky.

inclination to the natural sciences, was transferred, with the permission of the President of the Academy, to the Zoölogical Museum.

Thus, eleven years old, Vosnesensky entered the institution in which he was predestined to work all his life, to the last day.

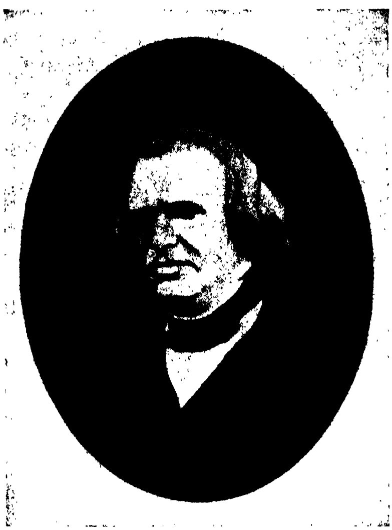

FIG. 253.—Ilya Gavrilovich Vosnesensky (1816–1871), adventurous and courageous Russian naturalist. Alone he spent years in the wilds of Siberia and Russian North America collecting biological and ethnological materials for the Imperial Academy of Sciences at St. Petersburg. During the period 1840–1841 he was at the Russian Colony Ross, in California and collected insects in that area and from the San Francisco Bay region north to New Helvetia (Sacramento). (From The Pacific Russian Scientific Investigations, Acad. Sci., U. S. S. R., 1926.)

In the Museum Vosnesensky was made an apprentice to E. P. Ménétriés,[362] Conserver [363] of the Chamber of Rarities, who took the boy along on the expedition to Caucasus, Transcaucasia, and to the shores of the Caspian Sea in 1829–1830.

In this expedition Vosnesensky showed for the first time his remarkable diligence and abilities. He not only collected a great number of insects and other objects, but even classified them according to the divisions and partly according to their genera.

His first salary was allowed him for this expedition through the influence of A. Kupfer, Member of the Academy, who reported to the Administration Committee (Nov. 13th, 1831) as follows: ". . . Regarding the fact that Ilya Gavrilovich Vosnesensky had always served with diligence and efficiency and contributed as much as he could to the success of our expedition, I, having the consent of Mr. Ménétriés, petition to the Administration Committee of the Imperial Academy of Sciences to reward Ilya Vosnesensky by allowing him a salary in accordance with the position he occupies. . . ."

Upon the return of the expedition Vosnesensky became an apprentice to E. I. Schrader, Conserver, and, owing to his ability and efficiency, was made Assistant Preparator with a salary of 400 rubles per year, paper currency.

On May 31st, 1839, T. T. Brandt, K. A. Trinius, and G. P. Bongard (H. G. Bongard?), members of the Academy, reported to the Conference [364] of the

[362] Spelled Ménétriér in the text.

[363] Conserver is equivalent to the French *conservateur* and is used by the translator in preference to the English conservator which might appear misleading to an English-speaking reader. Conserver is an office of the head of a subdivision of a museum.

[364] The Conference of the Academy is equivalent to the Board of the Academy.

Imperial Academy of Sciences about the desirability of dispatching a naturalist to the Russian possessions in America, who would make there collections for the Museums of Botany and Zoölogy.

For this purpose T. T. Brandt recommended to dispatch I. G. Vosnesensky, as the most suitable man for the office; the length of the expedition was estimated to be three years—a sufficiently long time to procure the largest possible number of species of plants and animals peculiar to the lands to be explored.

The Conference on its meeting of August 2nd of the same year decided to send I. G. Vosnesensky at the expense of the Museums of Botany and Zoölogy.[365] At the same time the Board of Directors of the Russian American Company offered to I. G. Vosnesensky the free use of the ships of the Company during the time he was to spend in the expedition. The Conference also decided to entrust I. G. with collecting the articles of interest for the Museum of Ethnology, for which purpose E. I. Schrader, Curator of the Chamber of Hand Made Articles, was directed to prepare, together with A. F. Postels, detailed instructions on the subject of making ethnological collections.

The instructions on collecting Zoölogical objects was worked out by T. T. Brandt, that on the subjects of plants by G. P. Bongard (H. G. Bongard?) and F. E. Fischer, Director of the Imperial Botanical Garden.

Eighteen days later (August 20th) I. G. was already on his way to N. W. America, on board the *Nicholas*, a ship of the Russian American Company.

First communications from I. G. were received by T. T. Brandt after one year. After the usual stops in Copenhagen and in Portsmouth (October 2nd) the voyage was without interruption to Brazil. I. G. reached Santa Cruz November 29th, when the period of rains was still continuing. The rich tropical vegetation of Brazil magnificently developed in that season of the year profoundly impressed Vosnesensky. He stayed there for more than three weeks, since the representatives of the Russian American Company were engaged there in purchasing a new ship for the needs of the colonies. During this involuntary stop I. G. made several short excursions in the vicinities of the town, collecting. The *Nicholas* resumed its route December 24th, passed Cape Horn January 16th, reached the rocky coast of Chile February 2nd, and anchored in the harbor of Valparaiso. On the third day of the arrival I. G. started on a ten-day excursion in the vicinities of the town, accompanied by his fellow-passengers, Salbers, a physician, and Zigneus, a priest. Fine weather favoured the trip and Vosnesensky was able to procure considerable material of scientific importance. On February 22nd the *Nicholas* got under way, directing its course towards Russian possessions in North West America, and reached New Archangel on Sitka Island, May 1st.

Vosnesensky was given a hearty welcome by I. A. Kuprianof, the former Director of the colonies, who ordered several natives at the disposal of I. G. in order that, after receiving the necessary training, they might be of some use to I. G. in his work.

[365] During the time of the expedition the salary of Vosnesensky was doubled, becoming 1,600 rubles per year. In addition to this a yearly allowance of 1,200 rubles was provided. This amount, as well as the complimentary salary of Vosnesensky, 2,000 rubles all together, was provided from the funds of the Museums of Botany and Zoölogy, and later, in part, from the funds of the Museum of Ethnology.

Soon after this Vosnesensky made a number of excursions to various Russian settlements in North West America, beginning with Fort Ross.

From this time on, as may be seen from the Proceedings of the Conference, numerous parcels began to arrive from Vosnesensky containing enormous collections for the Museums of Botany, Zoölogy, Mineralogy, and Ethnology.

In 1843 T. T. Brandt informed the Conference that the term of Vosnesensky's expedition was over, requesting at the same time to extend it, on account of its remarkable results, in order that Vosnesensky could visit Kamchatka and Kourilsky Islands. The request was granted by the Academy and the term of the expedition was extended twice again later on.

On July 9th, 1848, Brandt reported to the Conference that he had no letters from Vosnesensky for more than a year and that he was much disturbed over this. One month later, however, the arrival of a letter from Vosnesensky was announced to the Conference. The letter was dated "Nov. 17th, 1847," and informed them that on account of insurmountable difficulties encountered by Vosnesensky in his travels in Kamchatka, he was compelled to postpone his departure until the beginning of the next year, and he did not wish to miss the opportunity he had to go from Petropavlovsk to Ayan or to Okhotsk, and to return to St. Petersburg at the end of the same year.

In his letter of June 12th, 1848, Vosnesensky wrote that in consequence of his last travels in Kamchatka his health became so poor that physicians prohibited his returning to St. Petersburg through Okhotsk, by the land route, since his lungs would not stand the unhealthy climate of the continent and the long travel in a carriage. Thus he had no choice but to accept the offer of the Governor of Kamchatka to take a ship of the Russian American Company to Sitka, and thence, on a ship of the same Company, to continue his homeward voyage. The physicians believed that traveling in such conditions, enjoying a perfect rest, and breathing the pure air of the ocean, he would regain his health.

September 13, 1848, Vosnesensky left Petropavlovsk and on the 30th of the same month, after more than eight years' stay in northwest America, in Kamchatka, and on the adjoining islands, he sailed on board the *Atkha* for St. Petersburg.

The last letter from I. G. was dated "Dec. 1st, Honolulu, Oahu Island," and communicated that he was bringing a great quantity of baggage with him and that he wished the customs examination to be made in St. Petersburg and not in Kronstadt.

Vosnesensky returned June 23rd, 1849, having spent ten years on his expedition (1839–1849). In order to give an idea of the regions of the globe visited by Vosnesensky as well as of the itinerary of his numerous trips during the expedition I shall quote the entire report of I. G. presented to Brandt, the member of the Academy, as it appeared in D. I. Litvinov's work, The Bibliography on Siberian Flora.

"Dispatched by the Museum of Zoölogy of the Imperial Academy of Sciences for the purpose of investigating and collecting various natural objects in the American possessions of Russia, I started on my voyage around the world on s. *Nicholas* August 20th, 1839. During the voyage I visited the shores of Brazil (Rio de Janeiro) and Chile (Valparaiso). I arrived at Sitka Island May

1st, 1840. Having stayed there for a short time, I left New Archangel July 7th and reached the coast of New Albion, the Ross Colony, July 20th. I made a number of trips in Northern California until September 3rd, 1841. With the abolishment of the Russian settlements in California I returned to Sitka October 4th, 1841. In the same year, November 23rd, I started on a sea voyage to Lower California where I visited the vicinities of Loreto, Escondido Harbor, and Carmen Island, and returned to New Archangel March 19th, 1842. With the coming of summer I started from Sitka for Kodiak and from there to Kenai Bay. Having spent the winter in Kodiak, I went back to Sitka in March,

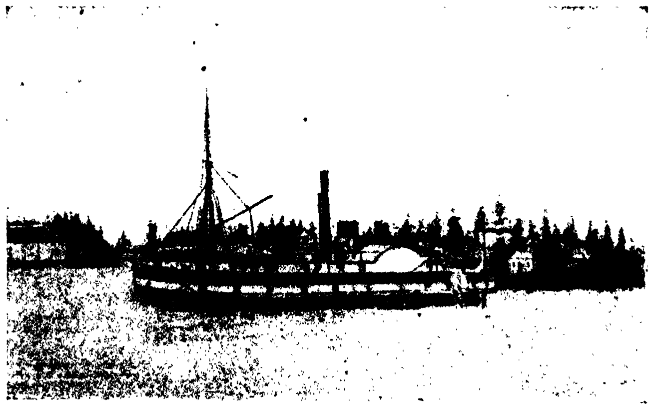

FIG. 254.—The S. S. *Nicholas I*, the Russian ship which carried Vosnesensky around much of the world to South America, Alaska, and finally to the Ross Colony, California, where he arrived July 20, 1840. (From a pencil sketch by Vosnesensky, Peter the Great Mus. Anthrop. and Ethnol., Imp. Acad. Sci., 1916.)

1843. In the beginning of May, I left for the Northern regions [meaning the regions of the Russian American Company], where I visited Unalaska and Unga Islands (in the Shumagin group) as well as the islands in the Bering Sea, namely, St. George, St. Paul, and St. Lawrence, the Michael Redout (on Steffens Island), and the Norton Sound. Thence I proceeded, through the Bering Straits, to the Arctic Ocean up to Kotzebue Sound, where my further advance was prevented by the ice-fields (July 11th–12th). Having surveyed Espenberg Promontory, I went across to the coast of Northeastern Asia, to Tchuktchas in Metchingmensky Bay, thence to Norton Sound again, and back, visiting on my return voyage Pribilof and Unalaska Islands (Illuluck village), and returned to Sitka October 11th, where I passed the next winter. In the spring of 1844, I started for Kurile Islands (April 24th) of which I visited Urup, Simusir, Paramusir, and Shoumsha. I left the islands July 6th for Petropavlovsk (Kamchatka), where I arrived July 17th; thence on July 25th, having taken a new ship, I proceeded towards Aleutian Chain, collecting all the time natural objects and articles on the following islands: Bering, Attu, Ataye, and on the Pribilofs for the second time, St. George and St. Paul. I returned to Sitka September 23rd, through Unalaska Straits. The end of the autumn was passed

in Kolotensky Straits, the winter in New Archangel. My travels in the North American possessions were over by May 16th, 1845. Having crossed the Pacific Ocean and Okhotsk Sea, I reached Okhotsk (June 29th), but my stay there was a brief one for I left it for Aian Harbor (July), and from July 13th, 1845 to July 31st, 1846 I traveled along the Eastern coast of Siberia. The Academy dispatched me then to explore the peninsula of Kamchatka. Having taken a transport vessel Kamchatka bound, I landed in Petropavlovsk August 14th. The brevity of the Kamchatkan summer compelled me to do my traveling during the winter. I started on my expeditions from Kamchatka Promontory (August 30th), and arrived at Karaga, having traveled along the Eastern coast of the peninsula. With the beginning of 1847 I started from Nizhne-Kamchatsk towards Petropavlovsk Port, and from there proceeded to the Western coast of Kamchatka, through Bolsherietzk, going first northward up to Oblukovina River, then going southward, to Lopatka. [It is evident from other papers of Vosnesensky that during the summer of this year, while returning from Oblukovina River through Bolsherietzk, he made a stop in Petropavlovsk—June 3rd to August 2nd,—and then went back to Bolsherietzk on his way to Lopatka, the southern extremity of the peninsula.] Late in the autumn, returning from Lopatka, I went to the sources of Kamchatka River, then to Kluchevskaya, then through Tighil Mountains, to Fort Tighil, and finally towards the mouth of Penjinsk Gulf, down to Lesnaya River; 1848 found me in the 'yurts' of nomadic Koryaks. I traversed the mountains, descended to Drankinskoye village, and then to Nizhne-Kamchatsk, along the Ukinsky shore. With the coming of spring my expeditions continued in various parts of Kamchatka till August 15th, when I returned to Petropavlovsk and began my preparations for my homeward voyage to Kronstadt. On September 13th I sailed (1848) from Petropavlovsk and arrived at St. Petersburg June 23rd, 1849, having visited Sitka, Hawaii, and Rio de Janeiro on my route."

The passage quoted above belongs to D. I. Litvinov. "Regarding the summer expeditions in Kamchatka, in 1848," adds Litvinov, "we have no detailed information from the report of I. G." From his other papers, however, it appears that Vosnesensky was in Petropavlovsk between April 1st and July 18th, and was engaged in an expedition to Malka village, through Knolsansky Mountains and Nitchikinskoye[366] between July 18th and August 5th.

A general characteristic of Vosnesensky's expedition and an estimate of its results may be found in the Proceedings of the Conference of the Academy of Sciences, in the papers appended to the records of his office, and in several publications of the Academic Museums.

In 1851 Prince M. A. Dunduckóff-Kórsackov, Vice-President of the Academy, wrote to the Minister of National Education on the subject of recommendation of Vosnesensky for a reward and promotion, as follows:

"The Conference of the Academy testifies that Vosnesensky accomplished his extremely difficult task with a most perfect success.

"The results of his remarkable expedition, their scientific importance, the value and variety of the collections, exceeded all expectations of the Academy.

[366] V. L. Bianchi, on the basis of the collection of birds, worked out a complete itinerary of Vosnesensky's expeditions in Kamchatka. The work is ready for the printer.

The objects and articles of ethnological, mineralogical, botanical, and zoölogical interest brought by Vosnesensky in 150 trunks will provide the richest material for the works of our natural scientists. Many new species of plants and animals are already described; their total number is above four hundred. The collections brought by Vosnesensky for the Museum of Mineralogy made it already possible for the Conserver of the Academy, K. I. Grewingk (C. Gerwingk?), to publish in 1850 an orographical and geological outline of the northwestern shore of America and of the neighboring islands. In addition to this material service to the Academy, Vosnesensky brought with him numerous notes, drawings, and sketches of great accuracy. He taught many persons living in those countries the art of the preparation and preservation of the specimens and they, according to his instruction, still are collecting various natural objects for the Academy.

"Such an example of an inborn talent and of faithfulness to duty as well as the material gain of the Museums, for which we are indebted to Vosnesensky, who risked his life and almost ruined his health for the sake of science, make it my duty to recommend him for a promotion and reward. . . ."

In another paper written after the death of I. G., Brandt, the member of the Academy, writes about the expedition of Vosnesensky: "During the nine years spent in the Far East, Vosnesensky with the greatest energy, overcoming all the obstacles, worked self-denyingly to enrich the Museums of the Academy with natural and ethnological collections of the objects and articles of these remotest lands. The variety of his collections and their abundance made, and still makes it possible, for the Museum of Zoölogy to exchange its duplicates with foreign museums, thus, in spite of its scanty means, always enriching its collections with new specimens. The collections of Vosnesensky became the source of the works of the following members of the Academy: Bear, Brandt, Middendorff, Schrenck, and Strauch, and there is not a single work on Zoölogy of eastern Siberia in which the name of Vosnesensky would not be mentioned with gratitude.

"Passing now to a more detailed discussion of the Vosnesensky collections, I must indicate that, being a zoölogist at heart, I. G. paid more interest to accumulation of zoölogical material, the tremendous value of which can be estimated on the basis of the comments of Brandt, then Director of the Museum of Zoölogy, and of Strauch's The Museum of Zoölogy at the Imperial Academy of Sciences—fifty years of its existence."

Brandt, in addition to the above mentioned estimate of Vosnesensky's works and collections, in the course of the latter's expedition, reported from time to time to the Conference of the Academy about numerous parcels from I. G. received by the Museum. In one of these reports (Sept. 11th, 1846) Brandt, upon receiving 27 trunks containing zoölogical specimens from Vosnesensky, wrote about the great value of the specimens, none of them having been damaged in any respect due to the excellent preservation. The total number of articles received up to that date amount to from 5 to 6 thousand, including one complete skeleton of a whale. The most valuable acquisition was the remnants of Steller's sea cow (*Rytina borealis stelleri*) consisting of skull, first vertebra, and parts of ribs together with several other bones, found by Vosnesensky on Bering Island.

Strauch in the above mentioned books writes: "Vosnesensky fulfilled his mission in a most brilliant way. The value of his collections is beyond estimation. The preparation and preservation are always perfect and his collections are of the best things that have ever been received by the Museum. Besides his collections I. G. made a great number of interesting observations in his diaries concerning the manner of living of various animals and the methods of hunting them, the flights of birds and their nesting, etc., although, unfortunately, he did not systematize them."

FIG. 255.—In June, 1841, Vosnesensky and Tschernikh were the first to ascend Mount St. Helena, California, which they named, and on the summit of which they placed a small inscribed copper plate announcing the event. The plate was removed in 1853 and subsequently destroyed in the San Francisco fire in April, 1906. It was restored, as illustrated, on the 100th anniversary of the founding of Fort Ross, in June, 1912. (From H. Toumey, 1923.)

Regarding the botanical collections of Vosnesensky, we find several mentionings in the Proceedings of the Conference of the Academy. Thus, Adjunct Meier, in 1843, informs that the Museum of Botany received a parcel from Vosnesensky containing dried plants, 21 species from Sitka and 71 from Kodiak Island, in addition to 113 species, 360 samples from California which were sent through Zagoskin. In 1846 the same Adjunct announced the arrival of a new parcel containing plants from Sitka, St. Paul, Unalaska, and Kodiak Islands and from Okhotsk, 160 species altogether in 550 samples. On the same subject we also find some information in Ruprecht's Outline of History of the Museum of Botany. On page 46 we find: "Vosnesensky's collections (1841–1846) from California, North West America, Aleutian and Kurile Islands, Kamchatka, and Bering Sea. The marine plants are discussed in detail in Alg. Ochot,[367] and sea-weeds and the most important marine plants from California (former Fort Ross) are the subject of my two special memoirs."

From the same paper we know that in the archives of the Museum of Botany

[367] By F. J. Ruprecht, member of the Academy, the author of the outline. (Probably his other work is meant: *Tange des Ochotskischen Meeres. Middendorff's Sib. Reise*, Band 1, Th. 2, Lief. 2, 1851.)

"The notes by Vosnesensky on the plants collected by him in Kamchatka, Bering Sea, Sitka Is., etc.," are preserved.

I. P. Borodin in his book *Collectionists and Collections of Siberian Flora* mentions the following Vosnesensky collections: 1. East Siberia, 1846; 2. Kamchatka and Aian, rec. 1847, 3. Kamchatka, 1848, 1060 specimens received in 1859, and 4. 16 blocks of trees from Kamchatka, received also in 1849. D. I. Litvinov in Bibliography on Siberian Flora says that Vosnesensky's botanical collections, although not quite skillfully made and perfectly complete, are very satisfactory in comparison with those of our former collectors. Vosnesensky himself estimated that all his plants can be arranged on 2,000 sheets.

Mineralogical collections of Vosnesensky were more abundant than others. A. F. Gebel in his brief outline of the history of the Museum of Mineralogy mentions Vosnesensky's collection. They are listed in the following order: 1841–Geological collections; 1846–Petrified and other rocks from North West America (220 samples); 1848–Geological collection from Urup Island; 1849–350 samples from Kamchatka; and 1851 "Petrified rocks of various formations," 185 samples.

In spite of a comparatively small volume of the mineralogical and geological collections they became the material for two memoirs of Dr. Grewingk.[368]

The collection for the Museum of Ethnology brought by Vosnesensky included an enormous number of articles peculiar to the civilization and households of the inhabitants of N. W. America, California, Aleutian and Kurile Islands; and of the Eastern extremity of Asia. He also acquired many articles at the places where he stayed on his route to N. W. America and back (Rio de Janeiro, Hawaiian Islands, etc.). A special article will be dedicated to a more detailed treatment of the subject, but I take the opportunity to indicate that these collections are of a far greater scientific interest than those made for the museums of the natural sciences, since the latter ones can be collected in the same lands even at the present time, while the majority of the articles of the ethnological collections are either unique or became so rare that only a few of the museums in Europe and America were able to procure them. The collections from N. W. America are especially valuable since the characteristic traits of the civilization of its inhabitants are rapidly vanishing due to the influence first of Russian and later of American traders and colonists. As to the number of the articles collected, although the exact number is not known, we may say that three-fourths of the total number of the articles in the North American Division were brought by Vosnesensky.

Upon the return of Vosnesensky in 1849 it was proposed to appoint him the Conserver which office became vacant after the resignation of Schrader. But since, in the words of A. Strauch, neither his origin nor his education did qualify him for "the office of rank," his appointment was made provisional, and only in 1852, with the permission of H. I. M. it was made permanent and he

[368] C. Gerwingk, *Beitrag zur Kenntniss der geognostischen Beschaffenheit Californiens*, Verh. der Russ. Kais. Mineral. Gesellsch. zu St. Petersburg, pp. 142–161 (1847).

Beitrag zur Kenntniss der orographischen und gegnostischen Beschaffenheit der Nord-West Küste Amerikas mit den anliegenden Inseln, Verh. der Russ. Kais. Mineral. Gesellsch. zu St. Petersburg, pp. 175–425 (1848–1849).

was promoted to the rank of "Collegial Registrator," [369] and in 1853 to the next rank, "Gubernal Secretary." In 1858 Vosnesensky married but became a widower three years later; of his marriage a daughter was born to him.

About the later work of Vosnesensky at the Museum many interesting facts may be found in the already mentioned book by A. Strauch, from which we will quote a few brief extracts.

"Succeeding Schrader, Vosnesensky assumed the duties of the latter, that is, the directorship of the technical laboratory and cataloguing of the new acquirements of the Museum. He was also entrusted with the supervision of the raw unclassified material accumulated in the storehouse. Ilya Gavrilovich was the only man indeed who could make head or tail out of the enormous mass of boxes, bales, and cans, etc., and without him Brandt himself would have been helpless. To his indefatigable work the Museum is indebted for the excellent conditions of the most valuable specimens of birds and animals which were not damaged or injured by moths in spite of the meagre means of their preservation. Although the duties of Vosnesensky laid solely in the field of technical supervision of the works, he was able to acquire a considerable amount of knowledge and skill in zoölogy, especially in the divisions of mammals and birds, so that he was able to arrange and classify preliminarily the incoming collections quite independently. Having a knowledge of German and partly of French, he could make scientific definitions, in particular, of birds. His principal specialization, however, were the fur animals; he became familiar with the subject during the time he spent in the North American possessions, and was regarded by furriers as a great authority in their trade. It was the plan of I. G. to organize the registration of visitors of the Museum of Zoölogy by means of the admission tickets, which enabled us to judge about the interest of the public in the Museum.

" In addition to the work at the museum which he loved a great deal, Vosnesensky was spending his time in studies and in participation in the activities of various scientific societies. In 1852 he was elected a member of the Russian Imperial Geographic Society and was very proud of his membership; in 1859 he became a charter member of the Russian Entomological Society. As a taxidermist, I. G. was also engaged in stuffing and preserving numerous animals killed during the hunting parties of the Czar. Alexander II, who knew I. G. personally, presented him with a ruby and diamond seal ring in 1858 for his services. In the same year the Emperor expressed his thanks to I. G. in the Winter Palace for mounting into a perfect shape the battle steed of the Emperor Nicholas I, 'Lord.'

"The last Imperial reward of Vosnesensky was The Order of Stanislaus, 3rd degree, which was conferred in 1867. During the last years of his life Vosnesensky's health became weak and he died of a lingering disease on the night of May 18th, 1871, being fifty-five years of age. He was buried in the Smolensky Greek-Catholic Cemetery.

"In the person of the deceased," says Strauch, "the Museum was deprived of an experienced director of the technical laboratory, of one of the most reliable and efficient workers."

[369] Collegial Registrator is the first and Gubernal Secretary the second rank of the former Imperial Civil Service Institute.

"Vosnesensky left a daughter, 13 years old, without any means of subsistence, since he was unable to make any savings during his whole life, which he consecrated to his beloved Museum. I. G. left a fortune to posterity, his enormous collections. They will remain for a long time an inexhaustible source for numerous scientific works the authors of which will recall the name of Ilya Gavrilovich with gratitude."

Fig. 256.—Francis Walker (1809–1874), the "most voluminous and most industrious writer on entomology England has ever produced." He has described American insects in many orders. (From W. L. Distant, 1907.)

Walker, Francis[370] (Fig. 256). Born at Southgate, England, July 31, 1809, and died at Wanstead, England, October 5, 1874. He is described as the "most voluminous and most industrious writer on entomology England has ever produced." He traveled a great deal and collected everywhere he went and thus amassed a great amount of material for the British Museum. He wrote 87 papers and is particularly noted for his catalogues of Orthoptera, Neuroptera, Homoptera, Diptera, Lepidoptera, and Hymenoptera (in part) and for his works on the Chalcididæ[371] (Hymenoptera). Of special interest to

[370] Swanison, W., *Bibliog. of Zoöl.*, p. 386 (1840).
Hagen, H. A., *Bibliot. Entom.*, vol. 2, pp. 251–255 (1863).
Can. Entom., vol. 6, p. 220 (1874).
Newman, Edw., *Can. Entom.*, vol. 6, pp. 255–259 (1874); Entom. Soc. Ontario, *6th Ann. Rept.*, pp. 22–24 (1875).
Entom. Mthly. Mag., vol. 11, pp. 140–141 (1874–1875).
Pet. Nouv. Entom., vol. 6, p. 453 (1874).
Nat. Canada, vol. 7, p. 184 (1875).
Strecker, H., *Butterflies and moths of N. Am.*, p. 278 (1878).
Distant, W. L., *Ins. Transvaaliensia*, p. 197, portrait (1907).
Wade, J. S., *Ann. Entom. Soc. Am.*, vol. 21, p. 519 (1928).
Horn, W., and Schenkling, S., *Index Litt. Entom.*, vol. 4, pp. 1281–1286 (1929).

[371] *Monographia Chalcidum*, Entom. Mag., vol. 1, pp. 12–29, 115–142, 367–384, 455–466 (1833); vol. 2, pp. 13–39, 148–179, 286–309, 340–369, 476–502 (1834); vol. 3, pp. 94–98, 182–206, 465–496 (1835); vol. 4, pp. 9–26, 349–364, 439–461 (1836); vol. 5, pp. 35–55, 102–118 (1837); vol. 6, pp. 418–431 (1838) (also as separate, London, Bailliere, 2 vols., vol. 1, 333 pp.; vol. 2, 100 pp., 15 pls. (1840–1842).

Western entomologists were his descriptions of insects from Vancouver Island in British Columbia,[372] many of which occur throughout the Pacific Coast region. Of the 93 species of Coleoptera which includes by far the largest group listed, 40 were described as new species. Of these only 3 or 4 species are now considered valid. Two new species of Lepidoptera were described, of which one is still valid. Of the Diptera four species were newly described of which two appear valid. Of the Hymenoptera, three new species were described by Walker, one of which appears to be still valid. He was elected an honorary member of the California Academy of Sciences, January 3, 1883. Walker did a tremendous amount of entomological work and described many species, a considerable number of which are of great interest or importance to much of North America. These are:

California dobson, *Neohermes californicus* (Walker).
Ant lion, *Hesperoleon ferox* (Walker).
Military grasshopper, *Pœcilotettix pantehrinus* (Walker).
Pale-spotted locust, *Melanoplus bilituratus* Walker.
Carinated shield bearer, *Neduba carinata* Walker.
Mexican ground cricket, *Nemobius mexicanus* Walker.
Black-horned tree cricket, *Œcanthus nigricornis* Walker.
Gralloblatta, *Grylloblatta campodeiformis* Walker.
Occidental termite, *Kalotermes occidentis* (Walker).
Basal treehopper, *Ceresa basalis* Walker.
Small sharp-headed leafhopper, *Dræculacephala minor* (Walker).
Spruce aphis, *Aphis abietina* Walker.
Grass aphis, *Macrosiphum dirhodum* (Walker).
Small rose aphis, *Myzaphis rosarum* (Walker).
Snow mosquito, *Theobaldia impatiens* (Walker).
Restless mosquito, *Aëdes impiger* (Walker).
White-faced tachina fly, *Sturmia albifrons* Walker.
American plum borer, *Euzophera semifuneralis* (Walker).
Fruit tree leaf roller, *Archips argyrospila* Walker.
Small corn stalk borer, *Diatræa lineolata* Walker.
Fig moth, *Ephestia cautella* Walker.
Pteromalus omnivorous Walker.
Monodontomerus æreus Walker.

Most of the named species are in the British Museum, with some in the Hope Museum, Oxford, and a part in the School of Medicine in Cairo, Egypt.

[372] Lord, John K., *The naturalist in Vancouver Island and British Columbia* (London, 1886), vol. 2, appendix, pp. 309–344.

Walsingham, Lord (Thomas de Gray) [373] (Fig. 257). Sixth Baron Walsingham. Born in Mayfair, London, England, July 29, 1843; died in London, December 3, 1919. He was a sportsman, naturalist, and a leading specialist in Microlepidoptera. He graduated from Cambridge University in 1865 and received the degree of M. A. in 1870 and was made High Steward and LL. D. in 1891. He was a man of large affairs, was a member of the House of Commons for West Norfolk, 1865–1870, succeeded to the title and estates of his father in 1870, and appointed a trustee of the British Museum in 1876. His wealth permitted him to travel a great deal and to purchase any specimens he desired for his work. He visited and collected quite extensively in Oregon and California during 1871–1872. As a result of this visit he described a great many small moths some of which are of considerable economic importance to California. He also later traveled to North Africa, Andalusia, Corsica, Italy, Sicily, Spain, Corfu, Germany, Austria, and Southern France. "Lord Walsingham joined the Entomological Society of London in 1866 and was President 1889–90 and Vice-President 1882, 1888, 1891–92, 1894–95; and, among other Societies, Zoöl. Soc. Lond. 1867; Royal Agr. Soc. 1871; Am. Ent. Soc. 1872; Br.

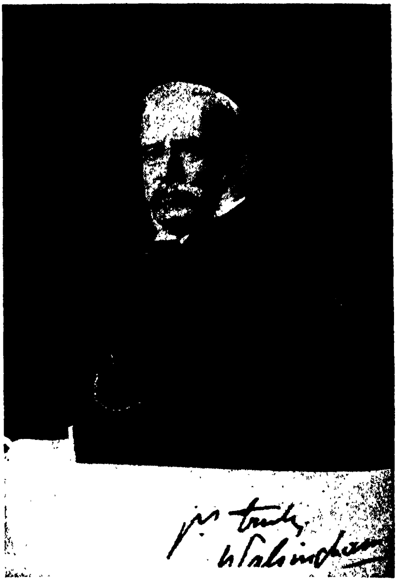

Fig. 257.—Lord Walsingham (1843–1919), English nobleman and microlepidopterist, who personally collected insects in California and Oregon in 1871–1872, and who described a number of moths from these states. (From Entom. Mthly. Mag., 1920.)

[373] *Vanity Fair Album*, vol. 14, p. 409, portrait (1882).
Bailey's Mag., vol. 56, p. 145, portrait (1891).
P. C. Jour. Entom., vol. 1, p. 171 (1909).
Busck, A., *Proc. Entom. Soc. Wash.*, vol. 22, pp. 41–43 (1920).
Entomologist, vol. 53, pp. 23–24 (1920).
Entom. Mthly. Mag., vol. 56 (3), vol. 6, pp. 17, 25–28, portrait (1920).
Entom. News, vol. 31, pp. 148–149 (1920).
Wade, J. S., *Ann. Entom. Soc. Am.*, vol. 21, p. 519 (1928).

Ornith. Union 1881; Linn. Soc. 1882; Ent. Soc. France 1882; Ent. Ver. Berlin 1890; Nederl. Ent. Ver. 1892; Ent. Soc. de Russie 1892; Linn. Soc. N. S. W. 1892; Royal Society 1887, etc."

His collection, which numbered 260,000 specimens of Microlepidoptera, was the finest in its day and contained material from Zeller, Hofmann, Christoph, and others. This collection was presented to the British Museum on April 1, 1910. Some duplicates are also in the Museum of Ipswich, England.

Of his publications the ones of most interest to Western workers are:

Illustrs. of Lepidoptera Heterocera in the British Museum, Pt. iv, North American Trotricidæ, xi+84 pp., pls. lxi–lxxvii (1879).

North American Coleophoræ, Trans. Entom. Soc. London, pp. 429–442, pl. xvii (1882).

North American Tortricidæ, British Mus., 12+84 pp., 17 pls. (1879); *Trans. Entom. Soc. London*, pp. 121–147 (1884).

Steps towards a revision of Chamber's Index, with notes and descriptions of new species, Insect Life, vol. 1, pp. 81–84, 113–117, 145–150 (1888), pp. 254–258, 287–291 (1889); vol. 2, pp. 23–26, 51–54, 77–81, 116–120, 150–155 (1889), pp. 284–286, 322–326 (1890), vol. 3, pp. 325–329, 386–389 (1891); vol. 4, pp. 384–385 (1892).

Notes on the genus Argyresthia *Hbn., with descriptions of new species*, Insect Life, vol. 3, pp. 117–120 (1890).

Description of a new tortricid from California, ibid., vol. 3, p. 465 (1891).

On his trip to the Western states he collected in southern California the largest known dragonfly in the United States, which Robert M'Lachlan named *Anax walsinghami*.

Some of the species of Microlepidoptera of interest are:

Platyptilia orthocarpi Wlshm.
Sunflower plume moth, *Oidæmatophorus helianthi* (Wlshm.).
Western plume moth, *Oidæmatophorus occidentalis* (Wlshm.).
Pink scavenger worm, *Pyroderces rileyi* (Wlshm.).
Brown apple moth, *Epicallima dimidiella* (Wlshm.).
Lesser apple worm, *Laspeyresia prunivora* (Wlshm.).
Catalina cherry moth, *Melissopus latiferreanus* (Wlshm.).
Apple skin worm, *Tortrix franciscana* (Wlshm.).
Abebæa subsylvella (Wlshm.).
Cypress moth, *Argyresthia cupressella* Wlshm.
Yerba santa gall moth, *Cœlopœta glutinosi* Wlshm.
Phyllonorycter ledella (Wlshm.).[374]
Cameraria gaultheriella (Wlshm.).[374]

[374] Walsingham described a great many species in these two genera.

Wheeler, William Morton [375] (Fig. 258). Born in Milwaukee, Wisconsin, March 19, 1865; at present professor of entomology, Bussey Institution for Research in Applied Biology, Harvard University, Forest Hills, Mass. Specialist in the embryology, morphology, and anatomy of insects, foremost authority on ants and other social insects. "Noted among American zoölogists for his broad scholarship and the extent and excellence of his research"; and more particularly as a leader, teacher, writer, and lecturer in entomology. The first nineteen years of his life were spent in his native city where he graduated from the German-American Normal College in 1884. On February 7 of that year he entered Wards' Establishment of National History, Rochester, New York,

FIG. 258.—William Morton Wheeler (1865–), eminent world authority on ants and social insects, and one of the greatest teachers, lecturers, and writers in the field of entomology. (Photograph, taken in August, 1916, furnished by Dr. L. O. Howard.)

where he remained until he returned to Milwaukee, June 29, 1885, to become a teacher of German and physiology in the high school under Geo. W. Peckham, with whom he later collaborated on a paper on spiders [376] and helped on wasps. During

[375] Wheeler, W. M., *Carl Akeley's early work and environment*, Natural Hist., vol. 27, pp. 133–141 (1927).
American Men of Science, p. 1050 (1927).
Who's Who in Am., vol. 15, p. 2196 (1928–1929).

[376] *Spiders of the subfamily Lysomanæ*, Proc. Wisc. Acad. Sci., Arts, and Letters (1888).

this period he spent much of his time studying embryology until 1890. On September 19, 1887, he was appointed custodian of the Milwaukee Public Museum where he remained until August 29, 1890, when he received a fellowship at Clark University under C. O. Whitman on October first of that year. Here he also acted as an assistant in zoölogy and received the Ph. D. degree in 1892. At this time he was appointed instructor in embryology at the University of Chicago where he remained until 1899, becoming assistant professor in 1897. During 1893–1894 he studied abroad at Würzburg and Liége and was also the occupant of the Smithsonian table at the Naples Zoölogical Station.

According to his own words his association with Peckham, Whitman, and William Patten made him a morphologist. Therefore much of his early work in embryology and morphology is in the general field of zoölogy. He was professor of zoölogy at the University of Texas, 1899–1903; curator of invertebrate zoölogy, American Museum of Natural History, 1903–1908, and honorary fellow and research associate since that time; professor of economic entomology, Bussey Institution 1908–1926 and professor of entomology since 1926; dean of the Bussey Institution, 1908–1930.

He is a fellow in the American Academy of Arts and Sciences, American Association for the Advancement of Sciences, Washington Academy of Sciences, New York Academy of Sciences, and the Texas Academy of Sciences; also a member of the American Morphological Society, American Society of Naturalists, American Society of Zoölogists (President of the east branch, 1908), National Academy of Sciences, American Philosophical Society, Entomological Society of America (President, 1908), and the Ecological Society of America; corresponding member of the Philadelphia Academy of Sciences, the Société Biologique de France, and honorary member of the Société Entomologique de Belgique and the Société Entomologique de France.[377]

Among his most important outside lectures are the following:

Social life among the insects—a series of six lectures delivered at the Lowell Institute in Boston, February 27 to March 16, 1922.[378]

[377] L. O. Howard is the only other honorary member among American entomologists.

[378] *These lectures were first published in the Scientific Monthly*, vol. 14, pp. 497–524 (1922); vol. 15, pp. 68–88, 119–131, 235–256, 320–337, 385–404, 527–541 (1922); vol. 16, pp. 5–33, 160–177, 312–328 (1923). They also appeared in book form—see writings below.

The Hitchcock Lectures [379] delivered at the University of California, March 26–April 3, 1928.

He has been a most prolific writer, particularly on ants. His papers have appeared in many periodicals but chiefly in Psyche, Journal of the New York Entomological Society, and Bulletin of the American Museum of Natural History. Some articles of general interest to workers in this country are:

Note on the oviposition and embryonic development of Xiphidium ensiferum *Scud.*, Insect Life, vol. 2, pp. 222–225 (1890).

Descriptions of some new North American Dolichopodidæ, Psyche, vol. 5, pp. 337–343, 355–362, 373–379 (1890).

New species of Dolichopodidæ from the United States, Cal. Acad. Sci., Proc. (3), vol. 1, pp. 1–80, 4 pls. (1899).

A genus of maritime Dolichopodidæ new to America, *ibid.*, pp. 145–152, 1 pl. (1899).

Diptera, family Empidæ (with Melander, A. L.), Biol. Centr.- Am., vol. 1, pp. 366–376 (1901).

The fungus-growing ants of North America, Bul. Am. Mus. Nat. Hist., vol. 23, pp. 669–807 (1907).

A European ant (Mymica levinodis) *introduced into Massachusetts*, Jour. Econ. Entom., vol. 1, pp. 337–339 (1908).

A revision of the ants of the genus Formica *(Linné) Mayr*, Camb. Mus. Comp. Zoöl., Bul., vol. 53, pp. 377–565 (1913).

An Indian ant introduced into the United States, *ibid.*, vol. 9, pp. 566–569, fig. 39 (1916).

Formicoidea, in Hymenoptera of Conn., Bul. 22, Conn. State Geol. and Nat. Hist. Surv., pp. 577–601 (1916).

Notes on some slave-raids of the Western Amazon ant (Polyergus breviceps *Emery*), Psyche, vol. 24, pp. 107–118 (1916).

The North American ants described by Asa Fitch, Psyche, vol. 24, pp. 26–29 (1917).

The mountain ants of western North America, Am. Acad. Arts & Sci., Proc., vol. 52, pp. 455–569 (1917).

A study of some ant larvæ, with a consideration of the origin and meaning of the social habit among insects, Proc. Am. Philos. Soc., vol. 57, pp. 293–343, 12 figs. (1918).

The parasitic Aculeata, a study in evolution, *ibid.*, vol. 58, pp. 1–41 (1919).

The Termitodoxa, or Biology and Society, Sci. Mthly., vol. 10, pp. 113–124 (1920). (Reprinted in *Foibles of insects and man*, 1928.)

Present tendencies in Biological Theory, *ibid.*, vol. 28, pp. 97–109 (Feb., 1929).

[379] *The evolution of animal and human societies*, March 26, 1928.
The rudimentary societies of insects, birds, and mammals. The societies of wasps March 27, 1928.
The societies of bees, March 28, 1928.
The societies of ants, April 2, 1928.
The societies of termites, April 3, 1928.

His most important books are:

A contribution to insect embryology (Boston, Ginn, 1893), 160 pp., 6 pls., illustrs.

The fungus-growing ants of North America (Cambridge, Mass., E. W. Wheeler, 1907), pp. 699–807, pls. xlix–liii.

Ants, their structure, development and behavior (New York, Columbia Univ. Press, 1910), xxv+663 pp., 286 figs.

Social life among the insects (New York, Harcourt, Brace & Co., 1923), vi+375 pp., 116 figs.

The social insects, their origin and evolution (Paris, Doin, 1926; London, Paul, Trench & Trubner; N. Y., Harcourt, Brace, 1928), xviii+378 pp., xlviii pls.

Emergent evolution and the development of societies (N. Y., Norton, 1928), xxvi+217 pp.

Foibles of insects and men (N. Y., Knopf, 1928), xxvi+217 pp.

Important species of American ants were named by Wheeler in the genera *Formica*, *Leptothorax*, *Pogonomyrmex*, etc., among which may be mentioned:

Leptothorax emersoni Wheeler.
Formica morsei Wheeler.
nepticula Wheeler.
Pheidole davisi Wheeler.

Ants, flies, and other insects from all over the world bear his name.

Williston, Samuel Wendell[380] (Fig. 259). Born in Boston, Mass., July 10, 1852; died at Chicago, August 30, 1918. Eminent American dipterist and paleontologist. Since his father was a blacksmith, he came of virile New England stock, physically endowed to fulfill a great and useful life. His family moved to Manhattan, Kansas, in 1857 where young Williston grew up and entered the Kansas State Agricultural College. Before finishing his course, however, he left college in 1870 to seek his fortune, first as a railroad laborer and later as a transit man in a surveying crew. Following many hardships and a severe attack of malaria he was forced to return home and after recuperating he finished his college course in 1872. He then began to study medicine with the family

[380] *Entom. News*, vol. 29, p. 321 (1918).
Brown, B., *Nat. Hist.*, vol. 18, p. 611, portrait (1918).
Aldrich, J. M., *Entom. News*, vol. 29, pp. 322–327, portrait (1918); *Can. Entom.*, vol. 51, pp. 39–41 (1919).
Ann. Entom. Soc. Am., vol. 12, p. 56, portrait (1919).
Lull, Richard S., *Am. Jour. Sci.* (4), vol. 7, pp. 220–224 (1919); *Mem. Nat. Acad. Sci.*, vol. 17, pp. 113–141, portrait (1924).
Wade, J. S., *Ann. Entom. Soc. Am.*, vol. 21, p. 520 (1928).

physician and during the summers of 1874–1875 he assisted one of his teachers, B. F. Mudge, who was then collecting fossils in western Kansas for O. C. Marsh of Yale University. In 1875 he received the degree of M. A. at Kansas and spent the winter of 1875–1876 studying medicine at the University of Iowa. In the spring of 1876 he accepted a position as assistant paleontologist under Marsh at Yale, where he also continued studying human anatomy. In 1877 Marsh put him in charge of a party to collect fossils in western Kansas and upon his return to Yale arrangements were made which enabled him to secure the degree of M. D. in 1880. He also received the degree of Ph. D. in paleontology in 1885 and received the appointment as demonstrator of anatomy at the Yale Medical School in September of the same year. In 1886 he became assistant professor of anatomy at Yale and in 1887 professor of anatomy. In 1886 also he was assistant editor of Science when the eminent entomologist Samuel H. Scudder was the editor. He was a health officer in the City of New Haven in 1886. He remained at Yale until 1890 when he left to accept the position of professor of historical geology, paleontology, and anatomy and dean of the Medical School at the University of Kansas, which position he held until 1902, when he became professor of paleontology at the University of Chicago where he remained until his death in 1918. In Kansas he was a member of the Kansas State Board of Health, 1898–1901, and a member of the Kansas State Board of Medical Examiners, 1901–1902.

FIG. 259.—Samuel Wendell Williston (1852–1918), eminent American paleontologist and entomologist, who became one of the leading world authorities on the Diptera. (After R. S. Lull, Mem. Nat. Academy of Sciences, 1924.)

In entomology he was one of a number of amateurs who attained

first rank in the subject, by his untiring devotion to it as a recreational pastime. He began studying beetles at Yale in 1876 [381] and took up the dipterous insects [382] a few years later. He advanced rapidly in the subject and soon became one of the leading authorities in Diptera and the outstanding one in the family Syrphidæ. In 1885 he declined an offer from C. V. Riley to become an assistant in the Division of Entomology and continued his studies of flies as a contribution separate and distinct from his professional career. He became a prolific writer in all of the subjects in which he became interested and his contributions in all fields may be itemized as follows: paleontology 138; entomology 97; geology 12; zoölogy 9; man 9; addresses 7; biography 5; bibliography 3, and public health 3; making in all 283 separate papers.

His most important entomological papers [383] of general interest and the smaller papers of importance to the West are:

Eristalis tenax, Can. Entom., vol. 13, p. 176 (1881).

New or little known genera of N. Am. Syrphidæ, *ibid.*, vol. 14, pp. 77–82 (1882).

Contributions towards a monograph of N. Am. Syrphidæ, Am. Philos. Soc., Phila., Proc., vol. 20, pp. 299–332 (1882).

Drosophila ampelophila, Can. Entom., vol. 14, p. 138 (1882).

N. Am. species of Conops., Conn. Acad. Sci. (New Haven), Trans., vol. 4, pp. 325–342 (1883).

Dipterous larvæ from the Western alkaline lakes and their uses as human food, *ibid.*, vol. 4, pp. 83–86 (1883).

The screw worm fly, Compsomyia macellaria, Psyche, vol. 4, pp. 112–118 (1883).

On the N. Am. Asilidæ, I, Dasypogoninæ, Laphrinæ, with a new genus of Syrphidæ, Trans. Am. Entom. Soc., vol. 11, pp. 1–36, pl. i–iii (1883), II, vol. 12, pp. 53–76 (1885).

Collection and preservation of Diptera, Psyche, vol. 4, pp. 130–132 (1884).

N. Am. Conopidæ: Stylogaster, Dalmannia, Oncomyia, Conn., Acad. Arts & Sci. (New Haven), Trans., vol. 6, pp. 87–94 (1884); pp. 377–394, xli+91 (1885).

On the classification of N. Am. Diptera, I, Bul. Brooklyn Entom. Soc., vol. 7, pp. 129–139 (1885); *II*, Entom. Americana, vol. 1, pp. 10–13 (1885); *III*, vol. 1, pp. 114–118, 152–155 (1886).

Synopsis N. Am. Syrphidæ, U. S. Nat. Mus., Bul. 31, xxx + 335 pp., 12 pls. (1886).

N. Am. Tachinidæ, Gonia, Can. Entom., vol. 19, pp. 6–12 (1887).

[381] His first paper was: *On the habits of* Amblycheila cylindriformis, Can. Entom., vol. 9, pp. 163–165 (1877).

[382] His first paper on Diptera was: *On an anomalous bombylid*, *ibid.*, vol. 11, pp. 215–216 (1879). His first important paper on Diptera was: *Some interesting new Diptera*, Conn. Acad. Arts and Sci. (New Haven), Trans., vol. 4, pp. 243–246 (1880).

[383] In all he published 97 papers on insects.

Notes and descriptions of N. Am. Tabanidæ, Kan. Acad. Sci. (Topeka), Trans., vol. 10, pp. 129–142 (1888).

Synopsis of the families and genera of N. Am. Diptera (New Haven, Conn., J. T. Hathaway, 1888), 84 pp.

Table of the families of Diptera, Kan. Acad. Sci. (Topeka), Trans., vol. 10, pp. 122–128 (1888).

The horn-fly, Entom. Americana, vol. 5, pp. 180–181 (1889).

An Australian parasite of Icerya purchasi, Insect Life, vol. 1, pp. 21–22 (1889).

Notes on the genus Lestophonus, *ibid.*, vol. 1, pp. 328–330 (1889).

Leucopis bellula, n. sp., *ibid.*, vol. 1, p. 257 (1889).

Diptera, Biologia Centrali-Am., vol. 3, pp. 1–80, pls. i, ii (1892).

N. Am. Psychodidæ, Entom. News, vol. 4, pp. 113–114 (1893).

Diptera of the Death Valley Exped., N. Am. Fauna (Wash., D. C.), vol. 7, pp. 253–259 (1893).

New genera of Bombyliidæ, Kan. Univ. Quart., vol. 3 (1894).

Manual of the families and genera of N. Am. Diptera (New Haven, Conn., J. T. Hathaway, 1896), liv+167 pp.; (ed. 3, 1908), 405 pp., 156 figs.

"The types of Williston's new species are much scattered. His Syrphidæ were acquired by the National Museum; the rest of his earlier collections by the University of Kansas; his *Biologia* material and that from St. Vincent went to London, and I understand were finally deposited in the British Museum; the American Museum of Natural History obtained his later collections, including some duplicates of type series from St. Vincent and perhaps Mexico. Williston did not believe in designating a single type specimen, hence in some cases his types of the same species are in two museums. He had no collection of Diptera in his last years, although he still retained his fine library in the order." [384] It was in paleontology that he made his greatest scientific contributions concerning which H. F. Osborn [385] states: "Williston's monographs [386] are chiefly on the Cretaceous mosasaurs and the archaic Reptilia of the Perm-Trias, to which he made most notable contributions." He belonged to many of the leading scientific societies in America, particularly those in entomology and geology, but he was specially interested in Sigma Xi of which he was vice president from 1899–1901, president 1901–1904, a member of the council 1895–1904, 1907–1909, 1910–1918.

[384] Aldrich, J. M., *Entom. News*, vol. 29, p. 325 (1918).

[385] *Encyclopedia Britannica* (ed. 13, 1926), vol. 31, p. 16.

[386] *Kansas mosasaurs, I*, Kan. Univ. Quart., vol. 1, pp. 15–32, pls. 2–6 (1892); *II*, pp. 83–84, pl. 3 (1893). Also *Univ. Geol. Surv., Kan.*, vol. 4, pp. 83–221, 5 figs., pls. 10–72 (1898).

North American plesiosaurs, I, Field Columbian Mus. Pub., vol. 73, pp. 1–77, pls. 1–29, 13 figs. (1903). *Am. Jour. Sci.* (4), vol. 21, pp. 221–236, 4 pls., 5 figs. (1906). *Jour. Geol.*, vol. 16, pp. 715–736, 15 figs. (1908).

American Permian vertebrates (Chicago, Univ. Press, 1911), 145 pp., 39 pls., 32 figs.

Permo-Carboniferous vertebrates from New Mexico, Carnegie Inst. of Wash., Pub. 181, 81 pp., 1 pl., 51 figs. (1913) (with Case, E. C., and Mehl, M. G.).

Osteology of reptiles. (Arranged and edited by W. K. Gregory) (Harvard Univ. Press, 1925), xiii+300 pp.

Some of the important Diptera named by Williston are:

Chrysops pachycera Williston.
Symphoromyia pachyceras Williston.
Sphærophoria melanosa Williston.
Physocephala affinis Williston.
Madremyia saundersi (Williston).
Frontina frenchi Williston.
Gonia porca Williston.
Dipterous parasite of cottony cushion scale, *Cryptochætum iceryæ* (Williston).
Leucopis bellula Williston.

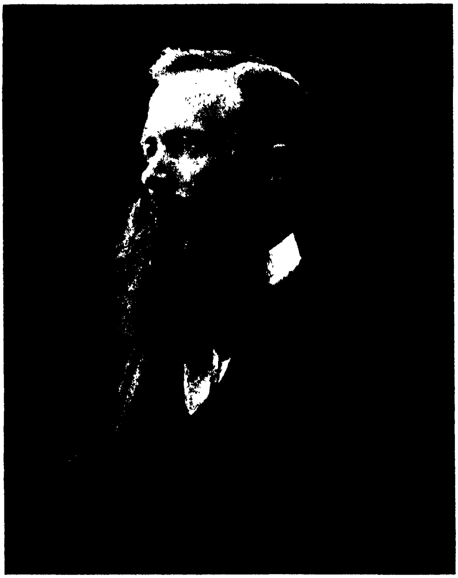

FIG. 260.—Charles William Woodworth (1865–) organized the entomological work at the University of California and served that institution from 1891 until his retirement in 1930. During this long period he has contributed much in the general fields of systematic and economic entomology. (From a photograph taken in Berkeley in 1900.)

Species of flies bearing his name are:

Lasioptera willistoni Coq.
Bombylius willistoni Coq.
Anthrax willistoni Coq.
Pantarbes willistoni O. S.
Asilus willistoni Hine.
Myopa willistoni Banks.
Chamæsyrphus willistoni Snow.
Chilosia willistoni Snow.
Euxesta willistoni Coq.

Woodworth, Charles William (Fig. 260). Born at Champaign, Illinois, April 8, 1865; at present chief entomologist, California Spray Chemical Company, Berkeley, California. One of the leading economic entomologists in the West. He was educated at the University of Illinois where he received the degree of B. S. in 1885 and M. S. in 1886. He afterwards attended Harvard in 1886–1888 and 1900–1901, and was an assistant to S. A. Forbes at the Illinois State Laboratory from 1884–1886. From 1888–1891 he was entomologist and botanist of the Arkansas Agricultural Experiment Station and was associated with the early work of economic entomology in the Middle West.

In 1891 he moved to California to become assistant in entomology at the University of California, Agricultural Experiment Station. He was made assistant professor of Entomology in 1891, associate professor in 1904 and professor in 1913–1930; and was also lecturer at the University of Nanking, China, in 1918, director of the Kiangsu Bureau of Entomology and honorary professor of entomology, National Southeastern University, Nanking, China, 1922–1924 (two and one-half years). He retired as emeritus from the University of California April 1, 1930, and accepted the position he now holds.

In the field of economic entomology in California he has played a most important part and has written a great many articles, bulletins, and circulars on the subject, chief of which are the following:

Jassidæ of Illinois, pt. I, Ill. State Lab. Nat. Hist., Bul. vol. 3, pp. 9–33 (1887).

Synopsis of North American Cicadidæ, Psyche, vol. 5, pp. 67–68 (1888); Cicadula, *ibid.*, pp. 75–76 (1889); Typhlocybini, *ibid.*, pp. 211–214 (1889).

Spray and band treatment for codling moth, Calif. Agr. Expt. Sta., Rept., 1890, pp. 308–311 (1891). (His first publication in California.)

A synopsis of the families of insects, *ibid.*, Rept., 1891–1892, pp. 271–314 (1892).

Remedies for insects and fungi, *ibid.*, Bul. 115, 15 pp. (1896).

California vine hopper, *ibid.*, Bul. 116, 14 pp., 4 figs. (1897).

Orchard fumigation, *ibid.*, Bul. 122, 33 pp., 22 figs. (1899).

Paris green for the codling moth (with Colby, Geo. E.), *ibid.*, Bul. 126, 40 pp., 1 fig. (1899).

Grasshoppers in California, *ibid.*, Bul. 142, 36 pp., 17 figs. (1902).

California peach-tree borer, *ibid.*, Bul. 143, 15 pp., 7 figs. (1902).

Red spiders of citrus trees, *ibid.*, Bul. 145, 19 pp., 5 figs. (1902).

Remedies for insects, *ibid.*, Circ. 7, 19 pp. (1903).

Fumigation dosage, *ibid.*, Bul. 152, 31 pp., 4 figs. (1903).

A list of the insects of California, with synopses, bibliography, and synonymy, published by author, Berkeley, Calif., 80 pp. (February, 1903).

Reading course in economic entomology, *ibid.*, Circ. 10, 20 pp. (1906).

Fumigation practice, *ibid.*, Circ. 11, 27 pp. (1904).

Silk culture, *ibid.*, Circ. 12, 6 pp. (1904).

Wing veins of insects, U. C. Pub., Tech. Ser. Entom., vol. 1, pp. 1–152, 101 figs. (1906).

Proposed insecticide law, Calif. Agr. Expt. Sta., Bul. 182, pp. 184–186 (1906).

Caterpillars on oaks, *ibid.*, Bul. 18, 4 pp. (1906).

White fly in California, *ibid.*, Circ. 30, 16 pp., 12 figs. (1907).

White fly eradication, *ibid.*, Circ. 32, 15 pp., 11 figs. (1907).

Argentine ant in California, *ibid.*, Circ. 38, 11 pp., 2 figs. (1908).

Fumigation studies, scheduling, *ibid.*, Bul. 207, pp. 53–82, 28 figs. (1910).

California insecticide law, ibid., Circ. 65, 23 pp. (1911).
Dosage tables, ibid., Bul. 220, 33 pp., 3 figs. (1911).
Guide to California insects (Berkeley, Law Press, 1913), 360 pp., 361 figs.
School of fumigation (Los Angeles, Braun Corp., 1915), 184 pp., 44 figs.
Microscope theory (Shanghai, China, Commercial Press, 1924), 240 pp., 132 figs.

Wrangell (Wrangel), Ferdinand Petrovich (1794–1870). Baron von Wrangell was Governor of Russian America and lived at Sitka. He visited at Ross in 1833 and again in 1835, when on his mission to Mexico. During this period he sent to the museum at Moscow a number of beetles which were subsequently described by Mannerheim.[387] Among those taken by him at Ross are:

Pterostichus ménétriési Mots. (Previously taken by Eschscholtz and also known as *P. ater* Dej.)
The rustic beetle, *Buprestis maculiventris* Say var. *rusticorum* (Kirby).
The gigantic eleodes, *Eleodes gigantea* Mann.
The grand eleodes, *Eleodes grandicollis* Mann.
The sulcate elodes, *Eleodes sulcipennis* Mann.

Wrangell passed through Ross late in 1835 on a special mission to Mexico relative to seeking the cession or sale of property east of Fort Ross including the Pueblo of Sonoma and the Mission San Rafael, and his failure to negotiate proper terms resulted in the withdrawal of the Russians from Ross in 1841.

Wright, William Greenwood[388] (Fig. 261). Born in Newark, New Jersey, about 1830; died in San Bernardino, California, December 1, 1912, at the approximate age of eighty-three. He had little education, was a soldier in the Civil War, and came to California soon after the close of the war. A few years were spent in Los Angeles, after which he moved to San Bernardino in 1873 where he operated a planing mill until about 1897. His only child died in infancy and his wife died soon after his retirement. His later years were entirely devoted to the study of butterflies and moths. In his early years of study he had known Wm. H. Edwards, Henry Edwards, Samuel H. Scudder, Herman Strecker,

[387] *Beitrag zur Käfer-Fauna der Aleutischen Inseln, der Insel Sitka und Neu-Californiens*, Bul. Nat. Hist. Moscow (1843).
[388] Coolidge, Karl R., *A day with* Euchloe cethura, Entom. News, vol. 24, pp. 91–92 (1913).
Grinnell, Fordyce, Jr., *Entom. News*, vol. 24, pp. 91–92 (1913).
Can. Entom., vol. 45, p. 116 (1913).

H. H. Behr, R. H. Stretch, and other lepidopterists of note. In his later years he worked almost entirely alone. He traveled to Mexico and throughout the Pacific Coast into Alaska, and wrote short papers in Zoe, Entomologica Americana, Canadian Entomologist, Papilio, Entomological News, and other periodicals. He rendered a distinct and valuable service to Wm. H. Edwards in the preparation of the Butterflies of North America,[389] and his most outstanding work is the Butterflies of the West Coast, published in San Francisco in October, 1905. In this book he attempted to sum up all the common knowledge of our western butterflies and figured each species in color. Due to the fact that most of the edition was destroyed in the fire of 1906, it has become quite rare and difficult to secure. The only available copies were turned over to the California Academy of Sciences along with his library and splendid collection of 6,000 to 7,000 specimens, after his death.

FIG. 261.—William Greenwood Wright (1830?–1912), early western botanical and entomological collector and lepidopterist, whose explorations in the desert regions of southern California revealed many interesting natural history specimens. (From the Butterflies of the West Coast, 1905. The original of this photograph is hanging in the entomological room of the California Academy of Sciences; see Fig. 42.)

He named a considerable number of new species, but most of those in his Butterflies of the West Coast have proven to be merely races or varieties of other species. Among his still valid species are:

Cercyonis stephensi Wright.
Euphydryas hermosa (Wright).
Strymon avalona Wright.
Hemileuca electra Wright.

[389] Published at Boston and New York in 3 volumes (1868–1897).

The following Lepidoptera were named for him:

Euphydryas wrighti (Edwards).
Adopæa wrighti (Edwards).
Melitæa wrighti Edwards.
Scepsis wrighti Stretch.
Cleora wrightiaria (Hulst).

Perhaps the most important and by far the most interesting insect named for him is the giant California palm borer, *Dinapate wrighti* Horn, a huge bostrichid beetle which lives in the dead native palms in the canyons bordering the desert areas of southern California. Concerning its discovery George H. Horn writes:[390]

For the fragments in my possession I am indebted to the untiring exertions of W. G. Wright of San Bernardino, California, a zealous botanist, for whom neither the privations incident to an exploration of the Mohave Desert nor the jealous watchfulness of the Indians, seemed to have had any terrors.

As the habits of this insect and its larvæ are now being investigated by Mr. Wright, I refrain from mentioning any matters of this character, as comparatively little is known except its food plant. It is to be expected that in the near future we will have full details from him. Should it prove to infest but the one plant it is likely to be at all times rare, and possibly disappear.

The beetle is confined to the California fan palm and is becoming increasingly more difficult to obtain due to the immediate destruction of dead palms to decrease the fire hazard for the living trees. During the month of July, 1927, F. H. Wymore noted that the larvæ and adults of this beetle were causing severe injury to fan palms replanted at Palm Springs. Large and small apparently healthy trees were riddled with the large burrows.

Xantus de Vesey, Louis John (John Xantus).[391] According to T. S. Palmer,

Xantus de Vesey was born in Csokonya, Hungary, October 25, 1825; died in Budapest, December 13, 1894. A Hungarian collector who came to America while still a young man and enlisted in the army. He served as hospital steward at old Fort Tejon, California, for about two years (1857–1858), during which

[390] *Trans. Am. Entom. Soc.*, vol. 13, p. 2 (1886).

[391] Also known as Johann Xantus and Jànos Xántus.

Hunfalvy, J., *John Xántus' reise durk die Kalifornische Halbinsel, 1858.* (Travels in the peninsula of Lower California in 1858), A. Petermann's Mittheilungen aus Justus Perthes' Geogr. anstalt, pt. v, pp. 133–143 (1861).

Nelson, Edward W., *Lower California and its natural resources*, Nat. Acad. Sci., Mem., vol. 16, p. 141 (1922).

Palmer, T. S., *The Condor*, vol. 30, p. 304 (1928).

time he collected extensively and described a number of new birds [392] including Hammond's flycatcher, *Empidonax hammondi* (De Vesey),[393] Cassin's vireo, *Vireo cassini* (De Vesey), and the southern spotted owl, *Strix occidentalis* (De Vesey).

He also collected at Fort Tejon a large series of Coleoptera consisting of one hundred forty-seven species, of which fifty-two were new as well as a number of new genera. These were described by the eminent coleopterist, John L. LeConte in 1858 [394] and 1859.[395]

Some of the important beetles collected by Xantus at Fort Tejon are:

Punctate snail eater, *Scaphinotus punctatus* (Lec.).
Rufous carabid, *Calathus ruficollis* Dej.
California pterostichus, *Pterostichus californicus* (Dej.).
Black burying beetle, *Necrophorus pustulatus* Hersch. var. *nigritus* Mann.
Silpha lapponica Hbst.
Hister remotus Lec.
Saprinus lugens Er.
Podabrus tomentosus (Say) (*P. pruinosus* Lec.).
    tejonicus Lec.
Enoclerus eximius (Mann.).
Cymatodera ovipennis Lec.
Red-legged ham beetle, *Necrobia rufipes* (De Geer).
Acmæodera connexa Lec.
    guttifera Lec.
Elater cordifer Lec.
Common carrion dermestid, *Dermestes marmoratus* Say.
Eleodes dentipes Esch.
    consobrina Lec.
    laticollis Lec. (Syn. of *E. acuticauda* Lec.).
    quadricollis Esch.
    scabrosa Esch.
    scabripennis Lec.

[392] *Descriptions of two new species of birds from the vicinity of Fort Tejon, California*, Acad. Nat. Sci., Phila., Proc., p. 117 (1858).

Catalogue of birds collected in the vicinity of Fort Tejon, California, with a description of a new species of Syrnum, *ibid.*, pp. 189–193 (1859). (In this paper 144 species are listed and one new species described.)

Baird, S. F., *Notes on a collection of birds made by Mr. John Xantus, at Cape St. Lucas, Lower California, and now in the Museum of the Smithsonian Institution*, Acad. Nat. Sci., Phila., Proc., pp. 299–306 (1859). (Collected in April, May, and June, 1859, 42 species.)

[393] Perhaps the editors of the scientific journals are responsible for using Xantus, De Vesey, or Vesey as an authorship name.

[394] Acad. Nat. Sci., Phila., *Proc.*, vol. 10, p. 187 (1858).

[395] *Catalogue of the Coleoptera of Fort Tejon, California*, *ibid.*, vol. 11, pp. 69–83 (1859).

Blapstinus brevicollis Lec.
pulverulentus Mann.
Coniontis abdominalis Lec.
Tenebrio molitor Linn.
Platyderma oregonense Lec.
Helops angustus Lec.
Hippodamia convergens (Guer.) (*H. punctulata* Lec. and *H. obsoleta* Cr.).
Ptinus verticalis Lec.
Lyctus planicollis Lec.
Scobicia declivis (Lec.).
Pleocoma fimbriata Lec.
Serica fimbriata Lec.
Hoplia callipyge Lec.
Xylotrechus nauticus (Mann.).
Phymatodes blandus (Lec.).
obscurus (Lec.).
Tetraopes mancus Lec.
Red-shouldered leaf beetle, *Saxinis saucia* Lec.
Blue milkweed beetle, *Chrysochus cobaltinus* Lec.
Western 12-spotted cucumber beetle, *Diabrotica soror* Lec.
Glyptoscelis albida Lec.
Rose snout beetle, *Rhynchites bicolor* Fabr.
Sitona californicus Fåhr.

Here also during the same period he collected one hundred twenty-two species of plants, a few of which were new species. These were described by Asa Gray.[396] Some animals were also taken here and in the neighboring region, notably the desert tree yucca lizard, *Xantusia vigilis* Baird, which was no doubt collected in the tree yucca belt of the Antelope Valley some fourteen miles from the Fort. Because of these extensive collections made by Xantus, Fort Tejon is the type locality for many insects, birds, other animals and plants and has become a sort of a biological shrine which has been visited by scientists from the world over.

Xantus left Fort Tejon about the middle of April, 1858, sailing from San Diego for Lower California. Concerning his activities there, Nelson[397] states:

This naturalist, commonly known as John Xantus, was employed as a tidal observer for more than two years, from April, 1859, to the middle of 1861, by the U. S. Coast Survey at Cape San Lucas. His letters state that he visited San José del Cabo, the Sierra Laguna, Todos Santos, La Paz, and Magdalena

[396] Gray, Asa, *List of collection of dried plants made by L. J. Xantus, at Fort Tejon, and vicinity, California, near Lat. 35°, and Long. 119°, 1857–8*, Boston Soc. Nat. Hist., Proc., 1859–1861, pp. 145–149 (1861). In this paper were described *Clarkia xantiana* Gray, *Pentstemon lætus* Gray and *Chorizanthe perfoliata* Gray.
[397] *Op. cit.*, p. 141 (1922).

Bay, in addition to traveling 350 miles up the West Coast. Xantus was sent to the cape by the Coast Survey in collaboration with the Smithsonian Institution. He made large collections in several branches of science, notably in plants,[398] in vertebrates, reptiles, and birds.[399] At the time of his visit the flora

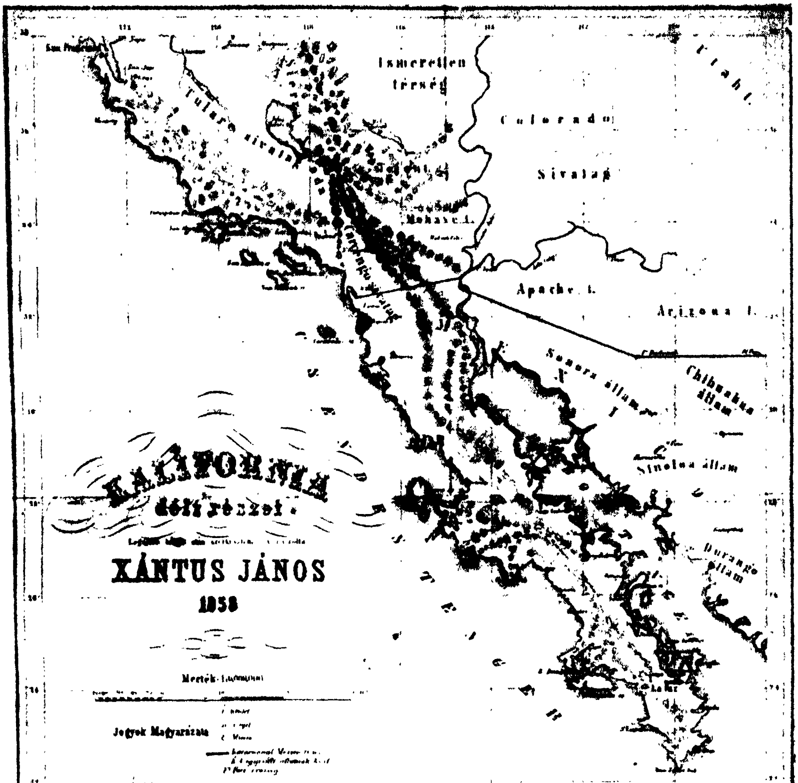

FIG. 262.—Map of a portion of California, Arizona and Lower California as prepared by Louis John Xantus, Hungarian naturalist, in 1858. The locations of the cities of Santa Cruz and Sonoma and the two Tulare Lakes are interesting. (From Utazás Kalifornia deli Reszeiben, 1860.)

and fauna of this region were practically unknown and his collections furnished numerous types and first drew attention to the peculiar and interesting flora and fauna of the cape district.

[398] Gray, Asa, *Enumeration of a collection of dried plants made by L. J. Xantus, at Cape San Lucas, etc., in Lower California, between August, 1859, and February, 1860, and communicated to the Smithsonian Institution*, Am. Acad. Arts & Sci., vol. 5, pp. 153–173 (Jan., 1861). This paper enumerated one hundred and twenty-one species, a number of which were new.

[399] Xantus, John, *Descriptions of supposed new species of birds from Cape Saint Lucas, Lower California*, Proc. Acad. Nat. Sci., Phila., pp. 297–299 (Nov., 1859) (four new species).

Some of the beetles from Lower California, sent to LeConte, were later described by Geo. H. Horn and G. R. Crotch.

He returned to Hungary in 1861 in which year he published a book on his travels in California,[400] which was reviewed by J. Hunfalvy in 1861.[401]

Among the insects which bear his name may be mentioned the following:

Eleodes veseyi Leconte (Syn. of *E. consobrina* Leconte). (Fort Tejon, California.)

Cymatodera xanti Horn (Lower California).

Pachybrachys xanti Crotch (Lower California).

Euplectroscelis xanti Crotch (Lower California, California, Arizona, Utah, Texas).

Pachymerus veseyi Horn (Lower California).

A collection of insects made by him in south and east Asia and the Malay Archipelago is in the Museum at Budapest.

Zeller, Philipp Christoph [402] (Fig. 263). Born at Steinheim-on-the-Murr, Würtemberg, Germany, April 9, 1808; died at Grunhof, Germany, March 27, 1883. World authority on Microlepidoptera. He began the study and collection of insects when a boy and his interest and knowledge never ceased until his death. Although he graduated from the Gymnasium and the University of Berlin he

[400] Xántus, Jànos, *Utazás Kalifornia déli Reszeiben* (Pesten, Kiadják Lauffer és Stolp, 1860), 191 pp., 6 pls., 1 map, 6 figs. A copy of this exceedingly rare book was borrowed from the Library of Congress, and although written in Hungarian, proved most interesting and instructive. The preface is dated at Cañon del Tejon, Kalifornia, October 5, 1858. This book was completely duplicated by the photostatic method by the Bancroft Library, University of California, where it is now available.

[401] Xántus, Johann, *Utazás Kalifornia déli Reszeiben*. Reviewed by J. Hunfalvy, *Johann Xántus' Reise durch die Kalifornische Halbinsel*, 1858. A. Petermann's *Mittheilungen aus Justus Perthes' Geogr. anstalt*, part v, pp. 133–143 (1861). (In German.)

[402] Hagen, H. A., *Bibliot. Entom.*, vol. 2, pp. 300–303 (1863).

Strecker, H., *Butterflies and moths of N. Am.*, pp. 279–283 (1878).

Dohrn, C. A., Entom. Zeit., *Entom. vereine zu Stettin*, vol. 44, pp. 406–412; bibliography, pp. 416–418 (1883).

Frey, H., *ibid.*, pp. 413–416 (1883).

Stainton, H. T., *Entom. Mthly. Mag.*, vol. 20, pp. 1–8, portrait (1883).

Carrington, J. C., *Entomologist*, vol. 16, p. 120 (1883).

Dunning, J. W., *Proc. Entom. Soc., London*, pp. xliv–xlvi (1883).

Grote, A. R., *Can. Entom.*, vol. 15, pp. 176–177 (1883); Entom. Soc. Ontario, *14th Ann. Rept.*, p. 82 (1883); *Papilio*, vol. 3, pp. 120–121 (1883).

Osten Sacken, C. R., *Record of my life work in entomology* (Cambridge, Mass., 1903), pp. 137–142.

Wade, J. S., *Ann. Entom. Soc. Am.*, vol. 21, p. 520 (1928).

Horn, W., and Schenkling, S., *Index Litt. Entom.*, vol. 4, pp. 1358–1362 (1929).

received no instruction in entomology and gained his knowledge by reading and actual experience. When he returned to the Gymnasium at Frankfort on the Oder in 1830 he devoted all of his leisure time to the study of Coleoptera, Diptera, and Lepidoptera, but he began specializing on the latter in 1833. His first paper[403] appeared in this same year. About this time also he began the study of Tineacea and later established the basis for the classification of the Tineacea, Crambina, *Lithocolletis*, and *Eudorea*. These important early papers were published in Isis,[404] Linnæa Entomologica[405] and Stettiner Entomologische Zeitung.[406] In 1849 his important paper on *Coleophora* appeared.[407] In 1852, shortly after he had received the title of Professor from the King of Prussia, he went to England in company with his friend C. A. Dohrn of Stettin, where he visited H. T. Stainton, Henry Doubleday and J. W. Douglas, with all of whom he had previously corresponded, as well as J. O. Westwood and others. He wrote many important papers in later years some of which were of importance to North America, such as:

FIG. 263.—Philipp Christoph Zeller (1808–1883), noted German entomologist and world authority on the Microlepidoptera. He has named and described some of the most important economic insects introduced into this country. (After H. T. Stainton, Entom. Mthly. Mag., 1883.)

North American Micro-Lepidoptera, Verhandlungen des zoölogisch-botanisch Vereins in Wien (1872, 1873, 1875).

Lepidoptera der Westküste Amerikas, *ibid.* (1874).

He also assisted H. T. Stainton in preparing the monumental *Natural History of the Tineina* (London, John Van Vorst, 1855, 1873), vols. 1–13.

[403] *Schmetterlinge von Europa by F. Treitschke*, vol. 9 (2), 262 pp. (1833).
[404] *Isis* (1838–1841).
[405] *Linnæa*, vol. 1, pp. 166–261, 262–318 (1846).
[406] *Stettiner Entomologische Zeitung*, vol. 3, pp. 139–143 (1842); vol. 4, pp. 281–283 (1843).
[407] *Linnæa*, vol. 4, pp. 191–416 (1849).

From his world viewpoint, Zeller, next to Hübner, laid the foundations for the study of the Microlepidoptera. He named and described a great many moths of economic importance the world over and some of which, now widely distributed in North America, are:

Lesser corn stalk borer, *Elasmopalpus lignosella* (Zeller).
Mediterranean flour moth, *Ephestia kuehniella* Zeller.
Wild grape plume moth, *Pterophorus delawaricus* (Zeller).
Potato tuber moth, *Phthorimæa operculella* (Zeller).
Eggplant leaf miner, *Phthorimæa glochinella* (Zeller).
Peach twig borer, *Anarsia lineatella* Zeller.
Apple fruit miner, *Argyresthia conjugella* Zeller.
Fungus moth, *Tinea defectella* Zeller.

His collection was purchased by Lord Walsingham who placed it in the British Museum, where it now is.

CHAPTER X

A CHRONOLOGICAL TABLE SHOWING THE DEVELOPMENT AND PROGRESS OF ENTOMOLOGY IN RELATION TO HISTORY AND OTHER SCIENCES

(Italics indicate entomologists, and entomological and allied data)

Births	Events	Deaths
C. Columbus (It.) 1446?–1506		
	1450 J. Gutenberg invented printing with movable type in Germany.	
Leonardo da Vinci (It.) 1452–1519		J. Gutenberg (Germ.) 1397?–1468
Nicolaus Copernicus (Pol.). 1473–1543		
	1474 Caxton printed first book in England.	
	1475 Conrad von Megenberg. Buch der Natur. ed. 2, 1478.	
Jacobus Sylvius (Fr.) 1478–1555		
G. F. de Oviedo y Valdes (Sp.). 1478–1557		
Martin Luther (Germ.) 1483–1546		
Henry VIII (Engl.) 1491–1547		
J. Agricola (Germ.) 1492–1566	1492 Columbus discovered West Indies, America.	
	1497 John and Sebastian Cabot discovered Labrador.	

Births	Events	Deaths
	1498 Vasco de Gama sailed round Cape of Good Hope to India.	
		C. Columbus (It.) 1446?–1506
G. Rondelet (Fr.) 1507–1556		
	1513 Balboa discovered the Pacific Ocean.	
Conrad Gesner (*Switz.*) *1516–1565*		
	1520 Magellan sailed across the Pacific.	Leonardo da Vinci (It.) 1452–1519
U. Aldrovandi (*It.*) *1522–1607*		
	1526 Oviedo y Valdes. General and natural history of the Indies. (Summary, 1526: First pt. 1535.)	
Joseph de Acosta (Sp.) 1539? (1540)–1600		
	1540 Coronado searched for the Seven Cities of Cibola. Garcia Lopez de Cardenas discovered the Grand Canyon of the Colorado.	
	1542 Sept. 28. Cabrillo entered San Diego Bay, and, in November, Monterey Bay.	
	1543 A. Vesalius. De corpis humani fabrica. Basel.	N. Copernicus (Pol.) 1473–1543
	1547 Portuguese brought first orange tree from China to Europe.	
	1551 Conrad Gesner. Historia animalium. Zurich, 1551–1558.	
Thos. Mouffet (*Engl.*) *1553–1604*		
	1555 G. Rondelet. Universæ aquatilium historiæ pars altera. 1555–1558, 2 pts.	Jacobus Sylvius (Fr.) 1478–1555

Births	Events	Deaths
		G. Rondelet (Fr.) 1507–1556
		G. F. de Oviedo y Valdes (Sp.) 1478–1557
	1560 Nicot introduced tobacco into France.	
Francis Bacon (Engl.) 1561–1626		
C. Schwenckfield (Germ.) 1563–1609		
Wolfgang Fanzius (Germ.) 1564–1628		
Wm. Shakespeare (Engl.) 1564–1616		
Galileo Galilei (It.) 1564–1642		
	1565 St. Augustine, Florida, founded by Spanish.	*Conrad Gesner (Switz.) 1516–1565*
		J. Agricola (Germ.) 1492–1566
Wm. Harvey (Engl.) 1578–1657		
	1579 Sir Francis Drake visited California.	
	1580 Coarse white paper made in England.	
	1584 Raleigh's first expedition landed in Virginia.	
	1586 Thos. Hariot took potatoes from America to Raleigh's Irish Estate.	
	1588 Acosta's Natural and moral history of the Indies.	
	1590 Hans and Zacharias Janssen, Holland, made first compound microscope.	
	1592 Prosper Alpinus proved that the date palm re-	

Births	Events	Deaths
	quired pollen to ripen fruit.	
	1593 Galileo invented the thermometer. Italy.	
	1600 H. Fabricius published sketches showing development of animals.	Joseph de Acosta (Sp.) 1539?–1600
	1602 U. Aldrovandi. De Animalibus insectis libri septem.	
	1602–1603 S. Viscaino explored the California Coast.	
		Andrea Cesalpini (It.) 1519–1603
		Thomas Mouffet (Engl.) 1553–1604
		U. Aldrovandi (It.) 1522–1605
Wenzel Hollar (Germ.) 1607–1677	1607 English settled at Jamestown.	
	1609 Charles Butler. The Feminine monarchie—or a treatise concerning bees. Oxford.	C. Schwenckfield (Germ.) 1563–1609
	1609–1618 Kepler announced laws of planetary motions.	
	1612 Wolfgang Fanzius. Animalium historia sacra.	
	1616 Wm. Harvey discovered the circulation of the blood. Announced in 1628.	Wm. Shakespeare (Engl.) 1564–1616
Johann Gœdart (Hol.) 1620–1668	1620 Pilgrims settle at Plymouth.	
	1620–1623 John and Kaspar Bauhin, botanists, developed a binomial nomenclature, but had no idea of early groups.	

Births	Events	Deaths
	1625 H. Fabricius illustrated work on development of the chick.	
	1625 Compound microscopes to be had in Holland, England, and France, but simple lenses favored.	
F. Redi (It.) *1626–1698*		Francis Bacon (Engl.) 1561–1626
M. Malpighi (It.) *1628–1694*	1628 Wm. Harvey. De motu cordis et sanguinis. Frankfurt.	*Wolfgang Fanzius (Germ.)* *1564–1628*
John Ray (Engl.) *1628–1705*		
A. von Leeuwenhoek (Hol.) *1632–1723*		
	1634 Thos. Mouffet. Insectorum sive minimorum animalium theatrum, etc. 1634–1658.	
Robt. Hooke (Engl.) 1635–1703	1635 French Academy of Arts and Sciences founded at Paris.	
J. Swammerdam (Hol.) *1637–1680*		
Martin Lister (Engl.) *1638–1711*	1638 Harvard College founded	
	1639 Stephen Daye established first printing press in America at Cambridge, Mass.	
		Galileo Galilei (It.) 1564–1642
Louis XIV (Fr.) 1643–1715	1643 Torricelli invented the barometer in Italy.	
	1645 Wm. Harvey. Zoötomia democritæ.	
	1646 W. Hollar. Muscarum, Scarabeorum, Vermium que variea figuræ.	
M. S. Merian (Germ.) *1647–1717*	1647 Geo. Fox founded the Society of Friends in England.	

Births	Events	Deaths
J. P. de Tournefort (Fr.) 1656–1708		
		Johann Gœdart (Hol.) 1620–1668
		Wm. Harvey (Engl.) 1561–1657
	1658 Swammerdam observed the red corpuscles in frog—not published until 1737.	
Hans Sloane (Engl.) 1660–1753		
	1661 M. Malpighi first to witness the circulation of blood.	
	1662 J. Gœdart. Metamorphosis et historia naturalis insectorum.	
	1662 Coffee first introduced into France.	
	1663 *Public Intelligence*, first newspaper published in England.	
	1664 Dutch surrendered New Amsterdam to British, became New York.	
	1665 Robt. Hooke. Micrographia.	
Johann L. Frisch (Germ.) 1666–1743	1666 M. Malpighi returned to Bologna from Messina.	
H. Bœrhaave (Hol.) 1668–1738	*1668 F. Redi. Experiments on the generation of insects refuted the idea of spontaneous generation.*	
	1669 M. Malpighi. Dissertatia epistolica de Bombyce, etc. London.	
	1669 J. Swammerdam. Historia insectorum generalis. Utrecht.	

Births	Events	Deaths
	1669 First tea brought to England.	
	1670 Hudson's Bay Company founded.	
Peter the Great (Russ.) 1672–1725	1672 N. Grew. The anatomy of vegetables. London.	
	1672 M. Malpighi. De ovo incubato.	
	1673 A. Leeuwenhoek discovered red corpuscles in blood.	
	1675 J. Swammerdam. Ephemeri vita. Amsterdam.	
	1675 A. Leeuwenhoek discovered Protozoa.	
	1675 M. Malpighi. The anatomy of plants.	
	1677 L. de Hamen described sperms of animals.	*Wenzel Hollar (Germ.) 1607–1677*
Mark Catesby (Engl.) 1679?–1749	1679 G. A. Borelli. De mortu animalium. Leyden.	
		J. Swammerdam (Hol.) 1637–1680
	1682 M. Lister translated J. Gœdart's work on insects into English.	
	1682 John Ray. Methodus plantarum nova. London.	
	1682 Philadelphia founded.	
R. A. F. de Réaumur (Fr.) 1683–1757		
	1684 Newton's theory of gravitation.	
	1685 A. Borelli. De motu animalium, ed. 2. Leyden.	
	1686 A. Leeuwenhoek observed capillary circulation of the blood.	

Births	Events	Deaths
	1687 A. Leeuwenhoek observed and described bacteria.	
	1687 M. Malpighi. Opera omnia. Leyden.	
	1691–1694 R. J. Camerarius proved the sexuality of plants.	
	1692 College of William and Mary founded in Virginia.	
	1692 Salem witchcraft.	
	1692 A. Leeuwenhoek worked out the life history of the flea.	
F. M. A. Voltaire (Fr.) 1694–1778		*M. Malpighi (It.) 1628–1694*
	1698 M. Malpighi. Opera posthuma. Amsterdam.	*F. Redi (It.) 1626–1698*
John Bartram (U. S.) 1699–1777		
A. Trembley (Switz.) 1700–1784		
	1701 Yale College founded.	
		Robt. Hooke (Engl.) 1635–1703
	1705 M. S. Merian. Metamorphosis insectorum Surinamensium. Amsterdam, 1703–1705.	*John Ray (Engl.) 1628–1705*
Benjamin Franklin (U. S.) 1706–1790		
P. Lyonet (Hol.) 1707–1789		
C. Linnæus (Sw.) 1707–1778		
G. L. L. Buffon (Fr.) 1707–1788		
		J. P. de Tournefort (Fr.) 1656–1708

Births	Events	Deaths
Joh. Gesner (Switz.) 1709–1790		
	1710 J. Ray. Historia insectorum. London.	
		Martin Lister (Engl.) 1638–1711
		Nehemiah Grew (Engl.) 1628–1712
Father Junipero Serra (Sp.) 1713–1784		
P. Kalm (Sw.) 1716–1779		
		M. S. Merian (Germ.) 1647–1717
Carl DeGeer (Sw.) 1720–1778	*1720 J. L. Frisch. Beschreibung von allerley insecten in Teutschland. 13 pts. Berlin, 1720–1738.*	
Charles Bonnet (Switz.) 1720–1793		
	1721 Inoculation for smallpox introduced into England.	
	1722 A. Leeuwenhoek. Opera omnia. Leyden.	
J. A. Scopoli (Austr.) 1723–1788		*A. von Leeuwenhoek (Hol.) 1632–1723*
Emmanuel Kant (Germ.) 1724–1804		
Dru Drury (Engl.) 1725–1803		Peter the Great (Russ.) 1672–1725
E. L. Geoffroy (Fr.) 1727–1810		
Capt. James Cook (Engl.) 1728–1779	1728 Vitus Bering, Danish navigator, discovered strait bearing his name.	
Lazzaro Spallanzani (It.) 1729–1799	*1729 Lawsuits in Amsterdam proved cochineal really an insect.*	

BIRTHS	EVENTS	DEATHS
	1730 De la Hire and Sédileau described and figured a scale insect of the orange tree.	
	1730 R. A. F. de Réaumur invented the Réaumur thermometer.	
J. A. E. Gœze (Germ.) 1731–1793		
Erasmus Darwin (Engl.) 1731–1802		
Moses Harris (Engl.) 1731–1785		
George Washington (U. S.) 1732–1799	1732 First stage between New York and Boston.	
	1732 Linnæus visited Lapland.	
Joseph Priestley (Engl.) 1733–1804		
	1734 R. A. F. de Réaumur. Mémoires pour servir à l'histoire des insectes. 6 vols. Paris, 1734–1742.	
	1735 C. Linnæus. Systema naturæ. 1st ed.–12th ed. 1768. Linnæus established the class Insecta and gave generic characters for first time.	
	1737 C. Linnæus. Genera plantarum.	
	1737 J. Swammerdam. Biblia naturæ. 2 vols. Leyden, 1737–1738. Published by H. Bœrhaâve.	
A. Modeer (Sw.) 1738–1799		*H. Bœrhaâve (Hol.) 1668–1738*
Wm. Bartram (U. S.) 1739–1823		
P. S. Pallas (Germ.) 1741–1811	*1741 Linnæus made professor at Upsala.*	

Births	Events	Deaths
Adam Kuhn (U. S.) 1741–1817		
K. P. Thunberg (Sw.) 1743–1828	1743 American Philosophical Society founded at Philadelphia.	
Joseph Banks (Engl.) 1743–1820		
J. F. W. Herbst (Germ.) 1743–1807		
Thos. Jefferson (U. S.) 1743–1826		
J. P. Lamarck (Fr.) 1744–1829	*1744 C. Linnæus in Systema Naturæ, ed. 4, settled on the number of orders of insects: Coleoptera, Hemiptera, Lepidoptera, Neuroptera, Hymenoptera, Diptera, Aptera. (Order names; Coleoptera, Hymenoptera, and Diptera were originally used by Aristotle.)*	
J. C. Fabricius (Denm.) 1745–1808	*1745 C. Bonnet observed parthenogenesis in aphis.*	
	1745 J. Bartram. Account of curious wasp nests made of clay in Pennsylvania. London.	
	1748 Per Kalm noted clothes moths and bedbugs in the American colonies.	
F. V. Melsheimer (Germ.) 1749–1814	*1749 G. L. L. Buffon. Histoire naturelle. 44 vols. Paris, 1749–1804.*	*Mark Catesby (Engl.) 1679?–1749*
J. W. von Goethe (Germ.) 1749–1832		
John Abbot (Engl.) 1750–1840		
	1751 J. Bartram. Observations on the inhabitants, cli-	

Births		Events	Deaths
		mate, animals, etc., from Pennsylvania and Canada.	
L. Gyllenhal (*Sw.*) *1752–1840*	1752	Franklin proved identity of lightning and electricity.	
F. Weber (*Denm.*) *1752–1823*	*1752*	*C. DeGeer. Mémoires pour servir à l'histoire des insectes. Stockholm, 1752–1778.*	
	1753	C. Linnæus. Species plantarum. Holmia.	Hans Sloane (Engl.) 1660–1753
	1754	French and Indian War began.	
	1754	Columbia University founded.	
G. W. F. Panzer (*Germ.*) *1755–1829*			
G. A. Olivier (*Fr.*) *1756–1814*			
C. G. Jablonsky (*Germ.*) *1756–1787*	*1756*	*M. J. Brisson redefined Linnæus' Class Insecta* (*Linnæus, 1735*).	
G. von Paykull (*Sw.*) *1757–1826*			*R. A. F. de Réaumur* (*Fr.*) *1683–1757*
James Monroe (U. S.) 1758–1831	*1758*	*C. Linnæus. Systema naturæ. Ed. 10, Holmia. Marked the beginning of the nomenclature of biology.*	
	1758	*C. Linnæus described cottony vine scale as* Coccus vitis (Pulvinaria).	
	1758	*C. Linnæus described the oyster shell scale as* Coccus ulmi (Lepidosaphes).	
	1758	*C. Linnæus described soft brown scale as* Coccus hesperidum.	

Births	Events	Deaths
M. M. I. de Robespierre (Fr.) 1758–1794	*1758 C. Linnæus described Florida red scale as* Coccus aonidum (Chrysomphalus).	
	1758 C. Linnæus erected the order Hemiptera.	
	1758 C. Linnæus named the bedbug, Cimex lectularius.	
	1758 C. Linnæus named the tarnished plant bug Cimex pratensis (Lygus).	
Wm. Kirby (Engl.) 1759–1850		
	1760 P. Lyonet. Traité anatomique de la Chenille qui ronge le Bois de Saule. A la Haye, 1760, 1762.	
J. Hübner (Germ.) 1761–1826		
P. A. Latreille (Fr.) 1762–1833	1762 M. A. Plenciz, Vienna physician, expressed the idea that all infectious diseases were caused by living organisms and that there was a specific organism for each disease.	
J. W. Meigen (Germ.) 1763–1845	*1762 E. L. Geoffroy. Histoire abrégée des insectes, etc. 2 vols. Paris. Later ed. in 1764.*	
W. D. Peck (U. S.) 1763–1822		
C. F. Fallén (Sw.) 1764–1830		
	1765 Wm. Shippen founded first medical school in America at Philadelphia.	*C. A. Clerck (Sw.) –1765*
	1765 James Watt invented steam engine with separate condenser. Scotland.	
	1765 Stamp Act passed.	

Births	Events	Deaths
B. S. Barton (U. S.) 1766–1815	*1766 Moses Harris. The Aurelian or natural history of English moths and butterflies, etc. London.*	
T. R. Malthus (Engl.) 1766–1834	*1767 G. Targioni-Tozzetti described the hemispherical scale as* Lecanium hemisphæricum (Saissetia).	
A. H. Haworth (Engl.) 1767–1833	*1767–1780 P. Pallas. Spicilegia zoölogica, etc. 2 vols. Berlin.*	
	1768 Angoumois grain moth known in America in 1743, first recorded in 1768.	
	1768 Adam Kuhn, first professor of botany in America at Philadelphia.	
	1768 British troops arrived in Boston.	
	1769	
F. H. A. von Humboldt (Germ.) 1769–1859	*Spanish introduced granary weevil, rice weevil, house fly, human flea, blue and green bottle flies, mange mites, etc., into California.*	
G. Cuvier (Fr.) 1769–1832	Fruits, walnuts, pear, citrus, olive, fig, pomegranate, etc., introduced into California by mission fathers.	
A. W. Wellington (Engl.) 1769–1852	Ortega and Portola discovered San Francisco Bay.	
Napoleon Bonaparte (Fr.) 1769–1821	Spanish founded first California Mission at San Diego.	
	1770	
C. R. W. Wiedemann (Germ.) 1770–1840	*D. Drury. Illustrations of natural history. London, 1770–1782.*	
A. L. M. Lepeletier (Fr.) 1770–1845	Presidio at Monterey founded June 3. California.	

Births	Events	Deaths
	1771	
G. Fischer von Waldheim (*Germ.*) *1771–1853* *Jacob Sturm* (*Germ.*) *1771–1848* *M. F. X. Bichat* (*Fr.*) *1771–1802*	*Landon Carter. Observations concerning the fly-weevil, that destroys the wheat. Philadelphia.*	
	1772	
E. Geoffroy Saint-Hilaire (*Fr.*) *1772–1844* *E. L. J. H. Boyer de Fonscolombe* (*Fr.*) *1772–1853* *C. J. Schœnherr* (*Sw.*) *1772–1848*	San Joaquin River discovered.	
	1773	
	Grasshopper plague in southern California. *C. DeGeer described the squash bug,* Cimex tristis (Anasa) *C. DeGeer erected the order Dermaptera to include all orthopterous insects.* Boston Tea Party.	
	1774	
P. A. J. Duponcel (*Fr.*) *1774–1846*	Priestly discovered oxygen.	
A. M. C. Duméril (*Fr.*) *1774–1860*	A. von Haller. Bibliotheca anatomica.	
	1775	
J. C. F. Klug (*Germ.*) *1775–1856* *J. C. W. Illiger* (*Germ.*) *1775–1815*	*J. C. Fabricius. Systema entomologica. Flensburg and Leipsig. Erected the order Rhyngota for the bugs.*	

Births	Events	Deaths
F. W. J. Schelling (Germ.) 1775–1854	*P. Cramer. Papillons exotiques des trois parties du monde l'Asie, l'Afrique et l'Amérique, etc. 4 vols. Amsterdam, 1775–1782.* Lieutenant Juan Manuel de Ayala in ship *San Carlos* first to sail through Golden Gate. August 5. Battle of Lexington marked the beginning of the Revolutionary War.	
	1776	
	J. C. Fabricius. Genera insectorum. Chilon. Founding of Mission and Presidio of San Francisco de Asis and San Juan Capistrano Mission. Declaration of Independence.	
	1777	
J. L. C. Gravenhorst (Germ.) 1777–1857 *J. A. Risso (Fr.) 1777–1845*	First pueblo in California established at San José. Washington at Valley Forge.	*John Bartram (U. S.) 1699–1777*
	1778	
A. P. de Candolle (Switz.) 1778–1841 C. A. Lesueur (Fr.) 1778–1846	*A. Modeer described the European elm scale as* Coccus spurius (Gossyparia). *C. DeGeer erected the order Suctoria for the fleas.* Treaty of alliance between United States and France.	*Carl DeGeer (Sw.) 1720–1778* *Carl Linnæus (Sw.) 1707–1778* F. M. A. Voltaire (Fr.) 1694–1778
	1779	
Lorenz Oken (Germ.) 1779–1851 *C. R. Sahlberg (Finl.) 1779–1860*	*Hessian fly discovered on Long Island, New York.*	*Per Kalm (Sw.) 1716–1779* James Cook (Engl.) 1728–1779

Births	Events	Deaths
	1780	
P. J. Dejean (*Fr.*) *1780–1845*	American Academy of Arts and Sciences Incorporated at Philadelphia.	
Leon Dufour (*Fr.*) *1780–1865*	Samuel Harrison invented the steel pen. England.	
M. M. Spinola (*Fr.*) *1780–1857*	Fire or pear blight first noted in New York by Wm. Denning.	
J. J. Audubon (U. S.) 1780–1851		
	1781	
A. Chamisso (Fr.) 1781–1838	*J. C. Fabricius. Species insectorum. Hamburg and Kilon.*	
	P. Pallas. Icones Insectorum præsertim Russiæ Sibiræque, etc. 4 pts. Erlangæ, 1781, 1782, 1798, 1806(?).	
	Los Angeles pueblo established. September 4.	
	Cornwallis surrendered at Yorktown.	
	Bank of North America established at Philadelphia.	
	1782	
F. E. Melsheimer (*U. S.*) *1782–1873*	*J. E. Bernard described the black scale as* Chermes oleæ (Saissetia).	
C. L. Nitzsch (*Germ.*) *1782–1837*	*J. Kerr described the lac insect as* Coccus lacca.	
	James Watt invented double action expanding steam engine. Scotland.	
	1783	
Wm. Spence (*Engl.*) *1783–1860*	*Chinch bug first noted as a pest of wheat in United States in North Carolina.*	
J. F. L. Hausmann (*Germ.*) *1783–1859*	Treaty of peace signed by Great Britain and United States.	

Births	Events	Deaths
	1784	
J. E. LeConte (U. S.) 1784–1860 *P. F. Bouché (Germ.) 1784–1856* *F. A. Bonelli (It.) 1784–1830*	*J. F. Herbst. Kurze einleitung zur kenntniss der insecten für ungeubte und anfanger. 3 vols. Berlin, 1784–1787.*	A. Trembley (Switz.) 1700–1784 Junipero Serra (Sp.) 1713–1784
	1785	
J. W. Zetterstedt (Germ.) 1785–1874	Agricultural societies organized at Philadelphia and at Charleston, S. C. *J. F. Herbst and C. G. Jablonsky. Natursystem aller bekannten in- und auslandischen insecten. 21 vols. Berlin, 1785–1806.*	*Moses Harris (Engl.) 1731–1785*
	1786	
E. F. Germar (Germ.) 1786–1853	*J. Hübner. Beiträge zur geschichte der schmetterlinge. 2 vols. Augsburg, 1786–1790.* *O. F. Müller. Animalcula infusoria. Also added materially to the knowledge of bacteria.* F. Vicq d'Azyr. Traité d'anatomie et de physiologie. Paris. La Perouse visited California. Andrew Meikle invented the threshing machine. Scotland.	
	1787	
Thomas Say (U. S.) 1787–1834	*J. C. Fabricius. Mantissa insectorum. Hafnia.*	*C. G. Jablonsky (Germ.) 1756–1787*
O. G. Costa (It.) 1787–1867	Robt. Squibb. The Gardener's Calendar for South Carolina and North Carolina, Charleston. First separate book on Horticulture in North America. Revised, 1809, 1827, 1842.	
J. E. Purkinje (Boh.) 1787–1869	Constitutional Convention at Philadelphia.	

Births	Events	Deaths
	1788	
	First American ships, *Columbia*, James Kendrick, and *Lady Washington*, Robt. Gray, appeared on the California coast.	*J. Scopoli* (*Austr.*) *1723–1788* G. L. L. Buffon (Fr.) 1707–1788
	1789	
Benedict Jæger (*Aust.*) *1789–1869* C. G. Carus (Germ.) 1789–1869	*G. A. Olivier. Entomologie, ou histoire naturelle des insectes, etc. 6 vols. Paris, 1789–1808.* *G. von Paykull. Mon. Staphylinorum Sueciæ. Upsala.* George Washington elected first president of the United States. Beginning of the French Revolution.	*P. Lyonet* (*Hol.*) *1707–1789*
	1790	
W. E. Leach (*Engl.*) *1790–1836* *H. E. Straus-Durckheim* (*Germ.*) *1790–1865*	*G. von Paykull. Mon. Caraborum Sueciæ. Upsala.*	Benjamin Franklin (U. S.) 1706–1790 Johannes Gesner (Switz.) 1709–1790
	1791	
John Curtis (*Engl.*) *1791–1862*	Wm. Bartram. Travels through North and South Carolina, Georgia, East and West Florida. Philadelphia. Bank of the United States founded.	
	1792	
W.S. MacLeay (*Engl.*) *1792–1865* Karl E. von Baer (Esth.) 1792–1876 *J. F. Stephens* (*Engl.*) *1792–1852*	*J. C. Fabricius. Entomologica systematica. 4 vols. Hafnia, 1792–1794. Erected the order Odonata for the dragonflies and damselflies.* *E. Donovan. The natural history of British insects. 16 vols. London, 1792–1813.* *G. von Paykull. Monographia Curculionum Sueciæ. Upsala.*	

Births	Events	Deaths
	American Philosophical Society, Philadelphia, appointed committee to collect materials for a natural history of the Hessian fly. New York Agricultural Society published a small volume of transactions. New York state granted sum to Columbia College to endow a professorship in agriculture. First mint in United States established at Philadelphia. Gas first used for illuminating purposes. Vancouver visited California.	
	1793	
J. P. Kirtland (U. S.) *1793–1877* *C. H. G. von Heyden (Germ.)* *1793–1866* *M. H. Rathke (Danzig)* *1793–1860* *J. F. Eschscholtz (Russ.)* *1793–1831* *Carlo Passerini (It.)* *1793–1857*	Corner stone of United States Capitol laid by Washington. Eli Whitney invented the cotton gin. United States.	*Charles Bonnet (Switz.)* *1720–1793* *J. A. E. Gœze (Germ.)* *1731–1793*
	1794	
J. Macquart (Fr.) *1794?–1855*	*J. C. Fabricius described the buffalo treehopper as* Membracis bubalus (Ceresa). W. D. Peck. Descriptions of four remarkable fishes taken near the Piscataqua in New Hampshire. First paper on systematic zoölogy published in America. Erasmus Darwin's "Zoönomia" in which he attempted to find out the laws of organic life.	M. M. I. Robespierre (Fr.) 1758–1794

Births	Events	Deaths
	1795	
T. W. Harris (*U. S.*) *1795–1856*	*W. D. Peck. The description and history of the cankerworm.* *F. Weber. Nomenclature entomologicus secundum entomologiana systematicum illustr., etc. Chilon and Hamburg.*	*C. Stoll* (*Hol.*) *–1795*
	1796	
C. H. Boheman (*Sw.*) *1796–1868* *A. A. Retzius* (*Sw.*) *1796–1860*	*P. A. Latreille. Précis des caractères génériques des insectes, etc. Bordeaux. Erected the order Thysanoura for all apterous insects and the order Orthoptera.* Cuvier announced that the Eocene fossils of Paris Basin were of extinct species of animals. Washington's farewell address. *Otter*, from Boston, first American ship to enter Monterey Bay. E. Jenner, English physician, made first vaccinations for smallpox. England.	
	1797	
F. W. Hope (*Engl.*) *1797–1862* Charles Lyell (Engl.) 1797–1875 *E. Mulsant* (*Fr.*) *1797–1880* *J. V. Audouin* (*Fr.*) *1797–1841* *A. L. Dugès* (*Fr.*) *1797–1838* *P. J. M. Lorquin* (*Fr.*) *1797–1873* *N. M. Hentz* (*Fr.*) *1797–1856*	*J. Abbot and J. E. Smith. The natural history of the rarer lepidopterous insects of Georgia. 2 vols. London.* *J. P. Lamarck. Mémoires de physique et d'histoire naturelle. Paris.*	

BIRTHS	EVENTS	DEATHS
	1798	
I. A. M. F. X. Comte (Fr.) 1798–1857	*G. von Paykull. Fauna Suecia; Insecta. 3 vols. Upsala, 1798–1800.* *E. Donovan. Epitome of the natural history of the insects of China. London.* T. R. Malthus. Essay on the principle of population, etc. London. Lithography invented by A. Senefelder. Bohemia. Thos. Wedgwood's experiments with photography published.	
	1799	
Ebenezer Emmons (U. S.) 1799–1863 *J. A. Boisduval (Fr.) 1799–1879* *C. J. P. Amyot (Fr.) 1799–1866* *L. A. A. Chevrolat (Fr.) 1799–1884* *F. E. Guérin-Méneville (Fr.) 1799–1874* *G. A. W. Herrich-Schaeffer (Germ.) 1799–1874* *Louis Reiche (Hol.) 1799–1890*	*G. Cuvier. Leçons sur l'anatomie comparée. 5 vols. Paris, 1799–1805.*	Geo. Washington (U. S.) 1732–1799 *A. Modeer (Sw.) 1738–1799* Lazzaro Spallanzani (It.) 1729–1799
	1800	
T. R. Peale (U. S.) 1800–1885 *C. Zimmermann (Germ.) 1800–1867* *Gené, C. G. (It.) 1800–1847*	*J. P. Lamarck first expressed views on evolution in lectures.* *J. W. Meigen. Nouvelle classification des mouches à deux ailes. Paris.* *M. F. X. Bichat. Traité des mémbranes (created histology). Paris.*	

Births	Events	Deaths
	United States Capital removed from Philadelphia to Washington.	
	1801	
Edward Newman (*Engl.*) *1801–1876* *J. T. C. Ratzeburg* (*Germ.*) *1801–1871* *J. T. Lacordaire* (*Fr.*) *1801–1870* *F. Dujardin* (*Fr.*) *1801–1860* *J. P. Rambur* (*Fr.*) *1801–1870* *J. van der Hœven* (*Hol.*) *1801–1868* *J. P. Müller* (*Germ.*) *1801–1858*	*J. P. Lamarck. Système des animaux sans vertèbres. Paris.* *J. C. Fabricius. Systema eleutheratorum. 2 vols. Kiel.* *J. C. W. Illiger. Magazin für insectenkunde. 6 vols. Braunschweig, 1801–1856.* *M. F. X. Bichat. Traité d'anatomie descriptive. Paris.* *F. Weber. Observations entomologicæ, etc. Kiel.* Vaccination for smallpox first performed in America.	
	1802	
Charles Aubé (*Fr.*) *1802–1869* *E. Ménétriés* (*Fr.*) *1802–1861*	*P. A. Latreille. Histoire naturelle, générale et particulière des crustacés et des insectes. Paris. Erected the insect orders: Parasita, Perlariæ, Megaloptera, and Panorpatæ.* *J. P. Lamarck. Recherches sur l'organisation des corps vivants* (*contains theory of the development of life*). *Paris.* J. P. Lamarck and L. C. Treviranus, separately, proposed term biology for the whole science of living things. *P. F. Dejean. Catalogue des Coléoptères de la collection d'Auguste Dejean. Paris, 1802–1837.* *Wm. Kirby. Monographia Apum Angeliæ. 2 vols. Ipswich.*	Erasmus Darwin (Engl.) 1731–1802 *M. F. X. Bichat* (*Fr.*) *1771–1802*

Births	Events	Deaths
	T. Marsham. Entomologica Britannica, etc. London. *P. A. Latreille founded the family Cicadidæ.*	
	1803	
J. G. Morris (U. S.) 1803–1879 *George Newport (Engl.) 1803–1854* R. W. Emerson (U. S.) 1803–1882	*J. C. Fabricius. Systema Ryngatorum secundum ordines, etc. Brunswick.* *Fabricius named the western blood-sucking cone nose,* Reduvius crassipes (Apiomerus). Louisiana purchased for fifteen million dollars.	*Dru Drury (Engl.) 1725–1803*
	1804	
Daniel Zeigler (U. S.) 1804–1876 Richard Owen (Engl.) 1804–1892 *K. T. von Siebold (Germ.) 1804–1895* *C. G. von Mannerheim (Sw.) 1804–1854*	*J. W. Meigen. Klassifikation und beschreibung der europäischen zweiflügligen insecten (Diptera). Brunswick.* First agricultural fair in America at Washington, D. C. October. John Gardiner and David Hepburn. The American Gardener. Second American book on horticulture. Washington. First orange trees grown at Mission San Gabriel in California.	Joseph Priestley (Engl.) 1733–1804 Emmanuel Kant (Germ.) 1724–1804
	1805	
J. O. Westwood (Engl.) 1805–1893 *Theodor Hartig (Germ.) 1805–1880*	*W. D. Peck elected first professor of natural history at Harvard College.* *J. Hübner. Sammlung Europaischer Schmetterlinge. Augsburg, 1805–1824.* *E. Donovan. General illustrations of Entomology. London.* *J. Sturm. Deutschlands insecktenkäfer. 23 vols., 425 col. pls. Nürnberg.*	

Births	Events	Deaths
	Fischer von Waldheim founded the Imperial Society of Naturalists at Moscow.	
	1806	
A. G. Dahlbom (Germ.) 1806–1859	*F. V. Melsheimer. Catalogue of the insects of Pennsylvania. Hanover, Pennsylvania.*	
C. A. Dohrn (Germ.) 1806–1892	*P. A. Latreille. Genera crustaceorum et insectorum secundum ordinem naturalem in familias disposita, etc. 4 vols. Paris, 1806–1809. Erected the hymenopterous suborder Phytophaga and the families Psyllidæ (Homoptera) and Coccinellidæ (Coleoptera).*	
	J. Hübner. Sammlung exotischer schmetterlinge. 2 vols. Augsburg.	
	J. Hübner. Tentamen. Augsburg.	
	J. C. Fabricius. Systema piezatorum secundum ordines, etc. Brunswick.	
	M. M. Spinola. Insectorum Liguriæ, etc. Genoa.	
	C. F. Fallén described the six-spotted leafhopper as Cicada sexnotata (Cicadula).	
	Count Resanof visited California in ship *Juno* to secure food.	
	1807	
L. Agassiz (Switz.) 1807–1873	Fulton's steamboat, *Clermont*, steamed from New York to Albany.	*J. F. W. Herbst (Germ.) 1743–1807*
H. Loew (Germ.) 1807–1879		
H. C. Burmeister (Germ.) 1807–1892		

BIRTHS	EVENTS	DEATHS
J. H. Kaltenbach (Germ.) 1807–1876 *G. Koch (Germ.) 1807–1881* *J. B. L. Buquet (Fr.) 1807–1889* *C. Rondani (It.) 1807–1879* H. W. Longfellow (U. S.) 1807–1882		
	1808	
B. D. Walsh (U. S.) 1808–1870 *P. C. Zeller (Germ.) 1808–1883*	*L. Gyllenhal. Insecta Suecica descripta. 1808–1827* Bernard M'Mahon. American Gardeners' Calendar. Philadelphia. First important American work on subject. Russian Kuskof sought place for settlement on California Coast.	*J. C. Fabricius (Denm.) 1745–1808*
	1809	
Asa Fitch (U. S.) 1809–1879 *Charles R. Darwin (Engl.) 1809–1882* *W. W. Saunders (Engl.) 1809–1879* *Francis Walker (Engl.) 1809–1874* *A. Brullé (Fr.) 1809–1872* *F. J. Pictet (Switz.) 1809–1872* *W. F. Erichson (Germ.) 1809–1849*	*J. P. Lamarck's views on evolution fully elaborated in his Philosophie zoölogique in which he also arranged animals according to relationships and was first to employ the genealogical tree. Vol. 2.* L. Oken. Naturphilosophie. Jena. *F. A. Bonelli. Observations entomologiques (Carabidæ). 2 pts. 1809–1813.*	

BIRTHS	EVENTS	DEATHS
A. Guenée (Fr.) *1809–1880* *J. A. Putzeys (Belg.)* *1809–1882* *O. Heer (Switz.)* *1809–1883* Abraham Lincoln (U. S.) 1809–1865 W. E. Gladstone (Engl.) 1809–1898		

1810

BIRTHS	EVENTS	DEATHS
Asa Gray (U. S.) 1810–1888 *L. L. Langsrtoth (U. S.)* *1810–1895* *Edw. Doubleday (Engl.)* *1810–1849* *G. R. Waterhouse (Engl.)* *1810–1888* *A. Förster (Færster) (Germ.)* *1810–1884* *F. L. Laporte de Castelnau (Fr.)* *1810–1880* *V. I. Motschulsky (Russ.)* *1810–1871*	*P. A. Latreille erected the orders Heteroptera (most often used as a suborder of Hemiptera) and Blattariæ.* Russian American Company negotiated with Spanish in California for trade. Casimiroa or zapote blanco introduced into Santa Barbara, California.	*E. L. Geoffroy (Fr.)* *1727–1810*

1811

BIRTHS	EVENTS	DEATHS
E. C. Herrick (U. S.) *1811–1862*	*G. A. Olivier redefined the order Orthoptera (Latreille, 1796).* *G. von Paykull. Monographia Histeroidum Suecicæ. Upsala.* First steamboat on the Ohio River. F. König invented cylinder printing press. Germany.	*P. S. Pallas (Germ.)* *1741–1811*

Births	Events	Deaths
	1812	
S. S. Haldeman (*U. S.*) *1812–1880* *S. S. Rathvon* (*U. S.*) *1812–1891* *S. A. de Marseul* (*Fr.*) *1812–1890*	*Academy of Natural Sciences, Philadelphia, founded.* G. Cuvier. Recherches sur les ossemens fossiles de quadrupèdes. Paris. Kuskof founded Russian settlement at Fort Ross and planted fruit trees there shortly afterwards. California. Earthquake destroyed the stone church of Mission San Juan Capistrano. California. War of 1812 began.	
	1813	
J. W. Randall (*U. S.*) *1813–1892* *Townsend Glover* (*Brazil*) *1813–1883* *M. E. de Selys Longchamps* (*Belg.*) *1813–1900*	*F. Germar. Magazin der Entomologie begun at Halle, Germany.* *J. A. Risso described the citrus mealybug as* Dorthesia citri (Pseudococcus). *Wm. Kirby erected the orders, Trichoptera and Strepsiptera.* A. P. de Candolle. Théorie élémentaire de la botanique.	
	1814	
Wm. LeBaron (*U. S.*) *1814–1876* *G. W. Dunn* (*U. S.*) *1814–1905* *P. H. Lucas* (*Fr.*) *1814–1889* *H. Feldman* (*Germ.*) *1814–1887*	*M. J. de Savigny. Observations sur la bouche des papillons, etc.* *W. E. Leach. Zoölogical miscellany. 3 vols. London, 1814–1818.* John Nicholson. The Farmers' Assistant. Albany, New York, ed. 2, 1820. American Monthly Magazine established by C. B. Brown. Steam cylinder printing press first used in printing the London Times.	*F. V. Melsheimer* (*U. S.*) *1749–1814* *G. A. Olivier* (*Fr.*) *1756–1814*

Births	Events	Deaths
	1815	
J. G. Schiödte (Denm.) 1815–1884	*J. P. Lamarck, Histoire naturelle des animaux sans vertèbres. 8 vols. Paris, 1815–1822.* *W. E. Leach published first bibliography of entomology in Brewster, Edinburgh Encyclopedia. Edinburgh.* *Wm. Kirby and Wm. Spence. Introduction to entomology. 4 vols. London, 1815–1826.* *Wm. Kirby restricted the order Dermaptera (DeGeer, 1773) to its present use.* *W. E. Leach founded the orders Phasmida, Anoplura, Thysanura (Thysanoura, Lubbock, 1869) and Raphidides; the hemipterous families Pentatomidæ, Coreidæ, Belostomidæ; the dipterous family Tipulidæ; and the hymenopterous family Chrysididæ.* Battle of New Orleans—End of War of 1812. Fall of Napoleon.	B. S. Barton (U. S.) 1766–1815 *J. C. W. Illiger (Germ.) 1775–1815*
	1816	
V. A. Signoret (Fr.) 1816–1889 *E. Desmarest (Fr.) 1816–1889* *M. de Chaudoir (Russ.) 1816–1881* *I. G. Vosnesensky (Russ.) 1816–1871* *G. Passerini (It.) 1816–1893*	*Wm. Kirby and Wm. Spence called attention to the value of ladybird beetles in destroying the hop aphis in England.* *J. Hübner. Verzeichniss bekannten schmetterlinge. Augsburg.* *G. Cuvier. Le règne animal. 4 vols. Paris, 1816–1817. Developed type-theory of animals.* *M. J. C. L. de Savigny. Mémoires sur les animaux sans vertèbres. 2 vols. Paris.* Otto Kotzebue visited San Francisco in the ship *Rurik*	

Births	Events	Deaths
	with A. von Chamisso and J. F. Eschscholtz.	
	California poppy collected at San Francisco by J. F. Eschscholtz and A. Chamisso.	
	1817	
H. A. Hagen (Germ.) *1817–1893*	*Thos. Say. American entomology. 3 vols. Philadelphia, 1817, 1825, 1828.*	Adam Kuhn, (U. S.) 1741–1817
R. A. von Kölliker (Switz.) *1817–1905*	*S. Ackerly. An account of the wheat insects of America (Hessian fly).*	
	W. D. Peck described the white pine weevil as Pissodes strobi. *He also published on the insect,* Anisandrus pyri (Scolytus), *which attacks the young branches of the pear.*	
	C. R. Sahlberg. Dissertatio entomologica insecta Fennica enumerans (Coleoptera). 2 vols. Abo, 1817–1834.	
	P. A. Latreille erected the orders Homoptera (redefined by J. O. Westwood, 1840) and Saltatoria (A. Handlirsch, 1925).	
	W. E. Leach established the orders Ephemerida and Physapoda and the coleopterous families Carabidæ, Cicindelidæ, Staphylinidæ, Telephoridæ, Elateridæ, Tenebrionidæ, Cerambycidæ, Curculionidæ, Scarabæidæ, and Mylabridæ; the dipterous families Tachinidæ and Hippoboscidæ; and the hymenopterous families Tenthredinidæ, Ichenumonidæ, and Apidæ.	
	Thos. Say. Fossil zoölogy (First American paper on invertebrate paleontology).	
	First school in California opened at Pueblo Los Angeles.	

Births	Events	Deaths
	1818	
H. H. Behr (Germ.) 1818–1904	*W. D. Peck described the carpenter worm as* Cossus robinæ (Prionoxystus).	
E. L. Taschenberg (Germ.) 1818–1898	New York Horticultural Society organized—first of kind in America.	
	J. W. Meigen. Sysmatische beschreibung der bekannten europäischen zweiflügligen insecten. 7 vols. Halle, 1818–1858.	
	C. G. Carus. Lehrbuch der Zoötomie. Leipzig.	
	Wm. Kirby. A century of insects, etc. London.	
	C. L. Nitzsch established the order Mallophaga.	
	1819	
H. R. Schaum (Germ.) 1819–1865	*Colorado potato beetle first discovered, 1819 or 1820.*	
	W. S. MacLeay. Horæ entomologicæ, or essays on annulose animals. 2 vols. London, 1819–1821.	
	W. E. Leach erected the dipterous families Asilidæ, Muscidæ, Syrphidæ, and Tabanidæ, the lepidopterous families Bombycidæ, Papilionidæ, Pyralidæ, Sphingidæ, and Tineidæ; the coleopterous families Bruchidæ, Chrysomelidæ, and Ptinidæ, and the hymenopterous families Pompilidæ and Uroceridæ.	
	American Farmer, first distinctively agricultural periodical in America, started at Baltimore.	
	Jethro Wood invented cast-iron plow of modern shape—United States.	
	Florida purchased from Spain.	

Births	Events	Deaths
	Fur seal and sea otter practically extinct in California. *Savannah*, the first transatlantic steamship built, crossed Atlantic.	
	1820	
Leon Provancher (Can.) 1820–1892 *Wm. MacLeay (Scotl.) 1820–1891* *O. Radoszkowsky (Russ.) 1820–1895* *E. A. H. Kiesenwetter (Germ.) 1820–1880* John Tyndall (Engl.) 1820–1893 Herbert Spencer (Engl.) 1820–1903	*Illustration of the Hessian fly in the American Farmer. Baltimore.* *Work of the corn earworm on cotton bolls described in American Farmer.* *C. F. Fallén. Monographia Musicdum Suecia. 9 parts. Lund, 1820–1824.* *P. A. J. Duponcel. Histoire naturelle des Lépidoptères de la France. Paris, 1820–1838.* *Fischer von Waldheim. Entomographia imperii russici, etc. 5 vols. Moscow.* C. G. Nees von Esenbeck, Handbuch der botanik. Nuremberg. K. Khlébnikof delivered 100 fruit trees to Fort Ross from Monterey, California. Missouri Compromise bill passed.	Joseph Banks (Engl.) 1743–1820
	1821	
Henry Ulke (Germ.) 1821–1910 R. L. C. Virchow (Germ.) 1821–1902 *P. Montrousier (Fr.) 1821–1897* *F. W. Mäklin (Finl.) 1821–1883*	*Straw worm,* Harmolita websteri *(How.), observed in wheat in Pennsylvania by James Worth.* A. Chamisso. Bemerkungen u. ansichten auf O. v. Kotzebues entdeckungs-reise. *F. Germar erected the homopterous family Membracidæ.*	Napoleon Bonaparte (Fr.) 1769–1821

Births	Events	Deaths
	1822	
W. H. Edwards (U. S.) 1822–1909 *J. A. Lintner (U. S.) 1822–1898* *H. T. Stainton (Engl.) 1822–1892* *Max Gemminger (Germ.) 1822–1887* *Charles Coquerel (Hol.) 1822–1867* *L. Pasteur (Fr.) 1822–1895* Johann (Gregor) Mendel (Aust.) (Silesia) 1822–1884	*J. F. Eschscholtz. Entomographien. Berlin, 1822–1823.* *P. F. Dejean and P. A. Latreille. Histoire naturelle et Iconographique de Coléoptères d'Europe. Paris, 1822–1824.* Gaslight introduced into Boston.	*W. D. Peck (U. S.) 1763–1822*
	1823	
Edward Norton (U. S.) 1823–1894 *Joseph Leidy (U. S.) 1823–1891* *A. R. Wallace (Engl.)* 1823–1913 *E. A. Ormerod (Engl.) 1823–1901* *J. H. Fabre (Fr.) 1823–1915* *C. Brunner von Wattenwyl (Aust.) 1823–1914* *J. V. Carus (Germ.) 1823–1903*	*T. W. Harris' first article on insects—the natural history of the salt marsh caterpillar.* *Peach tree borer described as* Ægeria exitiosa *by Thomas Say.* *Colorado potato beetle described as* Doryphora 10-lineata *by Thomas Say, from specimens collected in Missouri and Arkansas.* *W. E. Leach erected the dipterous family Œstridæ.* John Adlum. Memoir on the cultivation of the vine. Washington, 1823–1828. Gardiner Lyceum, a school to assist mechanics and farmers, by R. H. Gardiner, received grant of $1000 from the state of Maine.	Wm. Bartram (U. S.) 1739–1823 *F. Weber (Denm.) 1752–1823*

Births	Events	Deaths
	Don Luis Arguello appointed first Mexican Governor in California, 1823–1825. Monroe Doctrine proclaimed.	
	1824	
J. J. Rivers (Engl.) 1824–1913 *James Behrens (Germ.) 1824–1898*	*J. Curtis. British entomology. 16 vols. London, 1824–1840.* *L. Dufour. Recherches anatomiques sur les Carabiques et sur plusieurs autres Coléoptères. Paris, 1824–1826.* Treaty between Russia and the United States stopped Russian advance in California. Second visit to San Francisco by Otto von Kotzebue and J. F. Eschscholtz. Lafayette visited the United States.	
	1825	
J. L. LeConte (U. S.) 1825–1883 *Cyrus Thomas (U. S.) 1825–1910* *L. J. Xantus de Vesey (Hung.) 1825–1894* *H. W. Bates (Engl.) 1825–1892* T. H. Huxley (Engl.) 1825–1895	*Thomas Say joined the New Harmony colony in Indiana.* *Thomas Say described the grape leafhopper as* Tettigonia comes (Erythroneura). *Thomas Say described the box elder bug as* Lygæus trivittatus (Leptocoris). *P. A. Latreille erected the class Hexapoda, the order Siphonaptera; the suborder Nematocera; and the homopterous family Cicadellidæ.* Completion of the Erie Canal. First passenger steam railroad operated between Stockton and Darlington, England. Joseph Aspdin invented Portland cement—England.	

Births	Events	Deaths
	1826	
H. F. Bassett (U. S.) 1826–1902 *J. S. Harbison (U. S.) 1826–1912* *Carl Gegenbaur (Germ.) 1826–1903*	*Mediterranean fruit fly described from East India by C. R. W. Wiedemann.* *C. F. Fallén. Hemiptera Sueciæ. London, 1826, 1828.* *Wm. Kirby erected the order Aphinaptera for the fleas.*	*J. Hübner (Germ.) 1761–1826* *G. von Paykull (Sw.) 1757–1826* John Adams (U. S.) 1735–1826 Thomas Jefferson (U. S.) 1743–1826
	1827	
John Hamilton (U. S.) 1827–1897 Sir Joseph Lister (Engl.) 1827–1912 *E. C. A. Candèze (Belg.) 1827–1898* *P. F. Morawitz (Russ.) 1827–1896*	*W. Swainson established the lepidopterous family Nymphalidæ.* K. E. von Baer. De oui mammalium genesi. Leipzig. First railroad in the United States built at Quincy, Massachusetts. Improved steam cylinder press used to print London Times—5000 impressions per hour. John Walker invented friction matches. England.	
	1828	
C. R. Osten Sacken (Russ.) 1828–1906 *A. Costa (It.) 1828–1899* *Jacob Boll (Switz.) 1828–1880*	*H. E. Straus-Durckheim. Considerations générales sur l'anatomie comparée des animaux articules, etc. Paris. (Includes the anatomy of the May beetle.)* *J. van der Hœven. Handbœk der dierkunde. 4 vols. Amsterdam.* *J. W. Zetterstedt. Fauna insectorum Lapponica.* *J. F. Stephens. Illustrations of British entomology. 11 vols. London, 1828–1846.* *F. Walker erected the lepidopterous family Sesiidæ.*	

Births	Events	Deaths
	C. G. Carus. Grundzüge der vergleichenden Anatomie. Dresden.	
	K. E. von Baer. Über entwicklungsgeschichte der Tiere. Königsberg, 1828 and 1837. (Evolutional history and embryology.)	
	Roland Green. Treatise on the cultivation of flowers. Boston. (First American book dealing exclusively with flowers.)	
	A. D. Peacock discovered the larvæ of trichinella in the muscles.	
	A. Duhaut-Cilly visited Fort Ross, California.	
	1829	
J. B. Clemens (U. S.) 1829–1914	*J. A. Boisduval and J. E. LeConte. Histoire général et iconographie des Lépidoptères et des chenilles de l'Amérique septentrionale. Paris, 1829–1842.*	*J. P. Lamarck (Fr.) 1744–1829*
Ellwood Cooper (U. S.) 1829–1918	*J. F. Eschscholtz. Zoölogischer atlas enthaltend abbildungen neuer thierarten während Kotzebue's etc., zweiter reise um die welt, 1823–1826 gesammelt. Berlin, 1829–1833.*	*G. W. F. Panzer (Germ.) 1755–1829*
Matthew Cooke (Ireland) 1829–1887	*P. Lyonet. Anatomie de différentes espèces d'insectes. Paris, 1829–1832.*	
L. Fairmaire (Fr.) 1829–1906	*P. S. Schilling described the false chinch bug as* Heterogaster ericæ (Nysius) *and erected the hemipterous family Lygæidæ.*	
Franz Löw (Austr.) 1829–1889	*J. F. Stephens erected the siphonapterous family Pulicidæ, the hemipterous families Cimicidæ, Reduviidæ, Coreidæ (Leach, 1815), and Pentatomidæ; the homopterous families Aphidæ and Coccidea; the anoplurous family Pediculidæ; the coleopterous families Bupres-*	
H. L. F. de Saussure (Switz.) 1829–1905		

Births	Events	Deaths
	tidæ (also erected by J. F. Eschscholtz, 1829) and Dermestidæ; the hymenopterous families Mutillidæ, Formicidæ and Vespidæ; the lepidopterous families Tortricidæ, Ægeriidæ, Notodontidæ, Noctuidæ, Arctiidæ, Geometridæ, Hesperiidæ, and Lycænidæ; and the dipterous family Culicidæ.	
	P. F. Dejean, J. A. Boisduval and C. Aubé. Iconographie et histoire naturelle des Coléoptères d'Europe. 5 vols. Paris, 1829–1840.	
	J. N. Vallot described the ivy scale as Chermes hederæ (Aspidiotus).	
	Geo. Stephenson invented first successful steam locomotive—England.	
	1830	
V. T. Chambers (U. S.) 1830–1883	*J. F. Stephens erected the coleopterous family Nitidulidæ.*	*C. F. Fallén (Sw.) 1764–1830*
J. S. Bailey (U. S.) 1830–1883	*Boston Society of Natural History founded.*	*F. A. Bonelli (It.) 1784–1830*
J. G. Cooper (U. S.) 1830–1902	*Controversy between G. Cuvier and Geoffroy St. Hilaire on the fixity of types.*	
W. G. Wright (U. S.) 1830–1912	M. G. Vallejo planted orchard at Sonoma.	
Henry Edwards (Engl.) 1830–1891	Chas. Lyell. Principles of geology. London, 1830–1833. Refuted catastrophic view of the history of the world—substituted continuity.	
E. von Harold (Germ.) 1830–1886		
G. L. Mayr (Austr.) 1830–1908		
	1831	
G. Kraatz (Germ.) 1831–1909	*Bean weevil from Louisiana described as* Bruchus obtectus *by Thomas Say.*	*J. F. Eschscholtz (Russ.) 1793–1831*

Births	Events	Deaths
F. M. Brauer (Germ.) 1831–1904	*F. E. Guérin-Méneville. Magasin de zoologie, d'anatomie comparée et paleontologie. Paris, 1831–1845.*	James Monroe (U. S.) 1758–1831
	C. W. Hahn erected the hemipterous family Miridæ (G. W. Kirkaldy, 1894).	
	Robert Brown discovered the nucleus in plant cells.	
	Darwin started on voyage around the world in the *Beagle.* 1831–1836.	
	Invention of the reaper by Cyrus H. McCormick. United States.	
	Invention of dynamo electric generator.	
	1832	
	Thomas Say named the chinch bug, Lygæus leucopterus (Blissus). *Specimens from the coast of Virginia.*	J. W. von Goethe (Germ.) 1749–1832
	Pear psylla, Psyllia pyricola *Förster, thought to have been introduced into Connecticut from Europe about this time.*	G. L. Cuvier (Fr.) 1769–1832
	J. A. Boisduval. Faune entomologique de l'Ocean Pacifique, Voyage de l'Astrolabe. 2 vols. Paris, 1832–1835.	
	H. C. C. Burmeister. Handbuch der entomologie. 5 vols. Berlin, 1832–1855.	
	G. Newport. Nervous system of Sphinx ligustri. *London.*	
	J. A. Boisduval. L'entomologie du voyage autour du monde sur la Corvette la Coquille. 2 vols. Paris, 1832–1843.	
	A. Brullé established the order Isoptera for the termites.	
	P. A. J. Duponcel, J. B. Godart, and A. Guenée. Iconographie	

Births	Events	Deaths
	des chenilles, pour faire suite à l'histoire naturelle des Lépidoptères de France. Paris, 1832–1842.	
	Société Entomologique de France founded at Paris.	
	A. de Candolle. Physiologie végétale. Paris.	

1833

Births	Events	Deaths
J. H. B. Bland (U. S.) 1833–1911	*C. J. Schœnherr, L. Gyllenhal, and C. H. Boheman. Genera and species of Curculionidæ. 8 vols. Paris, 1833–1844.*	*A. H. Haworth (Engl.) 1767–1833*
Carl Stål (Sw.) 1833–1878	*F. Walker. Monographia Chalcidum. London, 1833–1842. Established the families Eurytomidæ and Pteromalidæ.*	*P. A. Latreille (Fr.) 1762–1833*
	F. L. Laporte de Castelnau. Essais d'une revision du genre Lampyre. Paris.	
	L. A. A. Chevrolat. Coléoptères du Mexique, 1833, 1841, 1843.	
	Greenhouse thrips, Heliothrips hæmorrhoidalis *(Bouché), noted injurious to greenhouse plants in Europe.*	

1834

Births	Events	Deaths
C. A. Blake (U. S.) 1834–1904	*J. T. Lacordaire. Introduction à l'entomologie, etc. 2 vols. Paris, 1834, 1838.*	*Thomas Say (U. S.) 1787–1834*
John Lubbock (Engl.) 1834–1913	*F. L. Laporte de Castelnau. Études entomologiques, etc. Paris.*	T. R. Malthus (Engl.) 1766–1834
F. D. Godman (Engl.) 1834–1919	*Suites à Buffon. Paris, 1834–1863.*	
Geo. Macloskie (Ire.) 1834–1920	*P. F. Bouché described the rose scale as* Aspidiotus rosæ (Aulacaspis).	
A. Weismann (Germ.) 1834–1914	*Elm leaf beetle,* Galerucella luteola *Müller, introduced into the United States about this time.*	
E. H. Hæckel (Germ.) 1834–1919		

Births	Events	Deaths
	C. W. Hahn described the harlequin cabbage bug as Strachia histrionica (Murgantia).	
	J. F. Stephens erected the suborder Anisoptera for dragonflies.	
	Entomological Society of London founded.	
	Secularization of the California missions began and continued until 1837.	
	Jacob Perkins invented the compressor ice machine—United States.	

1835

Births	Events	Deaths
P. R. Uhler (U. S.) 1835–1913	*J. A. Boisduval. Histoire naturelle des insectes. Paris.*	
Wm. Saunders (Engl.) 1835–1914	*O. G. Costa described the cochineal insect as* Dactylopius coccus.	
O. Salvin (Engl.) 1835–1898	*James Duncan. The Naturalists' Library. Edinburg, 1835–1841.*	
H. Landois (Germ.) 1835–1905	*Archiv für Naturgeschichte started in Berlin.*	
	J. F. Stephens erected the hymenopterous family Aphidiadæ for the parasites of aphis (changed to Aphidiidæ by A. H. Haliday, 1838).	
	F. Dujardin recognized protoplasm and called it sarcode (soft).	
	Samuel Colt invented the revolver—United States.	

1836

Births	Events	Deaths
F. H. Strecker (U. S.) 1836–1901	*A. L. M. Lepeletier. Hyménoptères. Histoire naturelle des insectes. Suites à Buffon. Paris, 1836–1845.*	*W. E. Leach (Engl.) 1790–1836*
	A. H. Halliday established the order Thysanoptera for thrips.	*C. W. Hahn (Germ.) –1836*

Births	Events	Deaths
	1837	
S. H. Scudder (U. S.) 1837–1911	Wm. Kirby. Insects in Richardson's Fauna Boreali-Americana, vol. 4, pt. 4. London.	C. L. Nitzsch (Germ.) 1782–1837
H. C. McCook (U. S.) 1837–1911	F. W. Hope. The Coleopterist's manual. 3 vols. London, 1837–1840.	
Robt. M'Lachlan (Engl.) 1837–1904	A. Guenée. Essai sur la classification de Noctuélides. Paris.	
E. B. Reed (Engl.) 1837–1916	J. T. C. Ratzeburg laid foundations for the study of forest insects in Die forestinsekten, etc. 3 vols. Berlin, 1837–1844.	
	J. Müller. Handbuch der physiologie des menschen. Coblenz, 1837–1840.	
	F. L. Laporte de Castelnau and H. Gory. Histoire naturelle et inconographie des Coléoptères. 4 vols. Paris, 1837–1841.	
	Elm leaf beetle, Galerucella luteola Müller, appeared at Baltimore.	
	F. Walker erected the hymenopterous family Encyrtidæ.	
	Wm. Kirby erected the hemipterous family Capsidæ; the coleopterous families Cleridæ and Scolytidæ; and the hymenopterous families Braconidæ and Siricidæ.	

Births	Events	Deaths
	1838	
E. T. Cresson (U. S.) 1838–1926	L. Reiche. Note sur le genre Omus d'Eschscholtz et description de deux nouvelle espèces.	A. Chamisso (Fr.) 1781–1838
C. H. Fernald (U. S.) 1838–1921	J. Macquart. Diptères exotiques nouveaux ou peu connus. Lille, 1838–1855.	A. L. Dugès (Fr.) 1797–1838
G. Sanborn (U. S.) 1838–1884	M. J. Schleiden and T. Schwann published on the cell theory, 1838–1839.	
C. T. Robinson (U. S.) 1838–1872	J. O. Westwood. The entomologists' textbook, etc. London.	
C. J. S. Bethune (Can.) 1838–		

Births	Events	Deaths
T. H. Cunningham (Can.) *1838–1921*	*H. C. C. Burmeister erected the order Mantodea.*	
George Marx (Germ.) *1838–1895*	*J. Macquart erected the dipterous family Mycetophilidæ.*	
L. von Heyden (Germ.) *1838–1915*	*A. H. Haliday established the hymenopterous family Aphidiidæ (Aphidiadæ, Stephens, 1835).*	
	C. G. Ehrenberg. Die infusionstiere als vollkommene organismen. Leipzig.	
	A. Dubini discovered the hookworm. Italy.	
	1839	
A. S. Packard (U. S.) *1839–1905*	*J. O. Westwood. An introduction to the modern classification of insects, etc. 2 vols. London, 1839–1840.*	
Maria E. Fernald (U. S.) *1839–1919*	*E. Mulsant. Histoire naturelle des Coléoptères de France. 13 pts. Paris and Lyon, 1839–1863.*	
S. F. Chapin (U. S.) *1839–1889*	*H. C. C. Burmeister erected the orders Corrodentia and Plecoptera.*	
Carl Fuchs (Germ.) *1839–1914*	*M. E. de Selys-Longchamps began publishing on Odonata.*	
Sven Lampa (Sw.) *1839–1914*	*G. Newport. Insecta in Todd's Cyclopædia of Anatomy and Physiology. London.*	
	T. Schwann. Mikroskopische untersuchungen. (Laid foundation of the cell theory.)	
	Alex. Forbes. History of Upper and Lower California. London.	
	Goodyear patented vulcanized rubber.	
	L. J. Daguerre made public his daguerreotype process.	
	1840	
G. H. Horn (U. S.) *1840–1897*	*I. G. Vosnesensky began to collect insects in California. 1840–1841*	*John Abbot (Engl.)* *1760–1840*

Births	Events	Deaths
W. M. Maskell (Engl.) 1840–1898	*E. Newman founded The Entomologist at London.*	*L. Gyllenhal (Sw.) 1752–1840*
David Sharp (Engl.) 1840–1922	*F. L. Laporte de Castelnau. Histoire naturelle des animaux articules, 4 vols. Paris.*	*C. R. W. Wiedemann (Germ.) 1770–1840*
Theo. Pergande (Germ.) 1840–1916	*J. O. Westwood erected the dipterous family Leptidæ; the homopterous family Aleyrodidæ; and the hymenopterous families Sphegidæ, Cynipidæ, and Chalcididæ.*	
Anton Dohrn (Germ.) 1840–1909		
J. C. Huguenin (Switz.) 1840–1926	*A. H. Haliday erected the hymenopterous families Mymaridæ, Dryinidæ, and Cephidæ.*	
E. D. Cope (U. S.) 1840–1897	*Boisgiraud employed* Calosoma sycophanta *Linn. to destroy the gypsy moth on poplar trees at Poitiers, France.*	
E. T. Atkinson (Ire.) 1840–1890	R. H. Dana, Jr. Two years before the mast. New York.	

1841

Births	Events	Deaths
L. E. Ricksecker (U. S.) 1841–1913	*T. W. Harris. Rept. on insects of Massachusetts, injurious to vegetation. Cambridge.*	*J. V. Audouin (Fr.) 1797–1841*
A. R. Grote (Engl.) 1841–1903	F. Dujardin. Histoire naturelle des infusoires. Paris.	A. P. de Candolle (Switz.) 1778–1841
	L. Oken. Naturgesichte für alle stande. Stuttgart.	
	Proceedings of Boston Society Natural History. First volume appeared.	
	First emigrant train reached California.	
	Russians vacated Fort Ross, California.	
	J. W. Wolfskill set out two acres of oranges in Los Angeles.	

1842

Births	Events	Deaths
A. J. Cook (U. S.) 1842–1916	*Work of corn earworm,* Heliothis obsoleta *(Fabr.), on corn reported in Illinois.*	

BIRTHS	EVENTS	DEATHS
I. C. Martindale (U. S.) *1842–1893*	*F. L. Laporte de Castelnau. Observations entomologiques sur les insectes de l'Amérique du Nord. Paris.*	
G. R. Crotch (Engl.) *1842–1874*	*J. P. Rambur. Faune entomologique de l'Andalousie. Paris.*	
O. Heidemann (Germ.) *1842–1916*	*M. H. Rathke. Beiträge zur vergleichenden anatomie und physiologie. Danzig.*	
E. L. Græf (Germ.) *1842–1922*	*Entomological society of Pennsylvania founded at York, in August. First in America.*	
	C. Darwin wrote first abstract on the theory of natural selection.	
	L. Agassiz. Nomenclator zoölogicus. 12 pts. 1842–1847.	
	R. A. von Kölliker described the formation of the blastoderm in the egg of the midge, Chironomus.	
	1843	
F. Blanchard (U. S.) *1843–1912*	*C. G. Mannerheim. Beitrag zur käfer-faune der Aletischen Inseln, der Insel Sitka und Neu-Californiens. Moscow. Suppls. 1846, 1852, 1853.*	
C. V. Riley (Engl.) *1843–1895*	*J. H. Kaltenbach. Monographie der familien der Pflanzenlause. Aachen.*	
Lord Walsingham (Engl.) *1843–1919*	*G. A. W. Herrich-Schaeffer. Systematische bearbeitung der schmetterlinge von Europa, etc. 6 vols. Regensburg, 1843–1856.*	
C. O. Waterhouse (Engl.) *1843–1917*	*R. Owen's lectures on the comparative anatomy and physiology of the invertebrate animals. London, 1853, 1855.*	
H. H. Robt. Koch (Germ.) *1843–1910*	M. Barry observed the union of sperm and ovum of the rabbit.	
	1844	
S. A. Forbes (U. S.) *1844–1930*	*P. A. J. Duponcel erected the lepidopterous family Pieridæ (1844, 1846).*	*E. Geoffroy Saint-Hilaire (Fr.)* *1772–1844*

Births	Events	Deaths
Otto Lugger (Germ.) 1844–1901 *E. A. Schwarz (Germ.) 1844–1928* *Patrick Manson (Engl.) 1844–1922*	*P. F. Bouché described the brown apricot scale as* Lecanium corni. Morse's telegraph from Baltimore to Washington completed.	
	1845	
G. W. Peckham (U. S.) 1845–1914 *W. L. Distant (Engl.) 1845–1922* *Charles Oberthur (Fr.) 1845–1924*	*W. S. W. Ruschenberger. Elements of entomology. Philadelphia.* *Antonio Villa. Degli insetti carnivori adoperati a disstrugere le specie dannose all'agricolture. (The carnivorous insects used to destroy the species injurious to agriculture.)* *F. Walker erected the hymenopterous families Eulophidæ and Eupelmidæ.* A. J. Downing. Fruits and fruit trees of America. (One of the most valuable early contributions on horticulture in America.) A. von Humboldt. Kosmos. Stuttgart. R. W. Thompson (England), and J. B. Dunlop (Ireland, 1888) invented pneumatic tires. R. Hoe and Co. invented double cylinder printing press. United States.	*J. W. Meigen (Germ.) 1763–1845* *P. F. M. A. Dejean (Fr.) 1780–1845* *A. L. M. Lepeletier (Fr.) 1770–1845* *J. A. Risso (Fr.) 1777–1845*
	1846	
G. D. Hulst (U. S.) 1846–1900	*F. E. Guérin-Méneville named* Hippodamia convergens. *Smithsonian Institution founded in Washington, D. C.* Amici and Robt. Brown demonstrated that pollen grains send out tubes which enter the micropiles of ovules.	*P. A. J. Duponcel (Fr.) 1774–1846* C. A. Lesueur (Fr.) 1778–1846

BIRTHS	EVENTS	DEATHS
	W. Engelmann. Bibliotheca historico-naturalis. Leipzig.	
	A. von Kölliker proved that sperms developed in the cells of the testes.	
	Hugo Mohl coined the word protoplasm.	
	K. T. E. von Siebold. Lehrbuch der vergleichenden anatomie. Berlin.	
	W. T. G. Morton gave first public demonstration in use of ether as an anesthesia in Massachusetts.	
	Alta Californian, first newspaper in California, begun at Monterey. August.	
	A. Robinson. Life in California. New York.	
	Fremont and party arrived in California.	
	Bear Flag Republic. June 14.	
	Commodore Sloat raised American flag at Monterey.	
	Donner Party tragedy in Sierras, 1846–1847.	
	S. W. Kearny first recorded the description of California or desert fan palm, *Washingtonia filifera* Wendl.	
	Howe's sewing machine patented in September—United States.	
	Mexican War began.	

1847

BIRTHS	EVENTS	DEATHS
J. H. Emerton (U. S.) 1847–	*J. Leidy. History and anatomy of the hemipterous genus* Belostoma. *Philadelphia.*	*C. G. Gené (It.) 1800–1847*
C. F. McGlashan (U. S.) 1847–		
O. N. Sanford (U. S.) 1847–		

Births	Events	Deaths
Peter Cameron (*Engl.*) *1847–1912* *Gustav Eisen* (*Sw.*) *1847–* *C. H. Dwinelle* (*U. S.*) *1847–*		

1848

Births	Events	Deaths
W. J. Holland (*Jamaica*) *1848–* *Edward Burgess* (*U. S.*) *1848-1891* *M. E. Murtfeldt* (*U. S.*) *1848–1913* *O. B. Johnson* (*U. S.*) *1848–1917* *B. P. Mann* (*U. S.*) *1848–1926* *Carlo Emery* (*It.*) *1848–1925* Hugo de Vries (Hol.) 1848–	*K. T. E. von Siebold established the phylum Arthropoda.* *American Association for the Advancement of Science organized.* *F. Dujardin. Zoölogie, animaux sans vertèbres. Paris.* *M. de Chaudoir. Mémoire sur la famille des Carabiques. 6 parts. Moscow, 1848–1857.* *Western cricket*, Anabrus simplex *Hald., invasion in Utah controlled by seagulls.* L. Agassiz. Bibliographia Zoölogiæ et Geologiæ. 4 vols. London. James W. Marshall discovered gold at Coloma, California—January 19 or 24. First English walnuts in Northern California planted at Calistoga by F. E. Kellogg.	*C. J. Schœnherr* (*Sw.*) *1772–1848* *J. Sturm* (*Germ.*) *1771–1848*

1849

Births	Events	Deaths
J. H. Comstock (*U. S.*) *1849–* *F. M. Webster* (*U. S.*) *1849–1916* *Louis Bedel* (*Fr.*) *1849–1922* *M. L. Linell* (*Sw.*) *1849–1897*	*T. B. Miner. The American bee-keepers' manual, New York.* First Constitutional Convention in California at Colton Hall, Monterey. September 1. Capital of California transferred from Monterey to Salinas. First session, California State Legislature held at Pueblo, San José, December 15.	*Edw. Doubleday* (*Engl.*) *1810–1849* *W. F. Erichson* (*Germ.*) *1809–1849*

Births	Events	Deaths
	E. Mulsant. Species des Coléoptères Trimères sécuripalpes. 2 parts. Lyon, 1849–1853.	
	A. Förster described the pear psylla, Psylla pyricola (Psyllia).	
	Hope Chair of zoölogy established at Oxford by F. W. Hope and occupied by J. O. Westwood.	
	A. von Humboldt. Ansichten der natur. Stuttgart.	
	J. W. Revere. A tour of duty in California. New York.	
	Gold Rush to California started.	
	First eucalyptus trees sent to California by Bishop William Taylor.	
	Peru exported first guano as fertilizer.	

1850

Births	Events	Deaths
H. G. Hubbard (U. S.) 1850–1899	California became a state, September 9.	*Wm. Kirby (Engl.) 1759–1850*
D. E. Salmon (U. S.) 1850–1914	*P. J. M. Lorquin began collecting Lepidoptera in California.*	
G. H. Field (U. S.) 1850–	*Mexican orange maggot,* Anastrepha ludens (Leow), *known to have previously infested oranges and other fruits at Morelos, Mexico.*	
Alexander Craw (Scotl.) 1850–1908	Fugitive slave law passed.	
	Thomas Nelson invented rotary printing press—England.	

1851

Births	Events	Deaths
H. H. Smith (U. S.) 1851–1919	*L. Agassiz. On the classification of insects from embryological data. Washington.*	J. J. Audubon (U. S.) 1780–1851
David Starr Jordan (U. S.) 1851–	*A. H. Haliday erected the dipterous family Phoridæ.*	*Lorenz Oken (Germ.) 1779–1851*
F. M. Balfour (Engl.) 1851–1882	*J. Curtis and Wm. Kirby erected the dipterous family Pipunculidæ.*	

Births	Events	Deaths
	J. C. Chenu and E. Desmarest. Encyclopédie d'histoire naturelle etc., 3 vols. Paris, 1851–1860.	
	T. Bilharz discovered the blood fluke and dwarf tapeworm. Egypt.	
	Guavas introduced into California about this time.	
	Yosemite Valley discovered. May.	
	Singer sewing machine patented—first with vertical needle.	
	Scott Archer invented process of making dry plates for taking photographs.	
	Cable across the English Channel.	
	1852	
G. Dimmock (U. S.) 1852–1930	*J. A. Boisduval. Lépidoptères de la Californie. Paris, 1852–1855.*	Duke of Wellington (Engl.) 1769–1852
S. W. Williston (U. S.) 1852–1918	*J. B. L. Buquet. Note sur les insectes Coléoptères recueillis en Californie par M. Lorquin. Paris.*	*J. F. Stephens (Engl.) 1792–1852*
C. S. Minot (U. S.) 1852–1914	*Honeybee introduced into California by C. C. Shelton.*	
James Fletcher (Engl.) 1852–1908	*J. L. LeConte. On the geographical distribution of animals in California. Albany, New York.*	
A. Kœbele (Germ.) 1852–1924	*E. Mulsant. Opuscules entomologiques. 13 vols. Paris, 1852–1863.*	
W. H. Harrington (Can.) 1852–1918	K. F. W. Ludwig. Lehrbuch der physiologie des menschen. Heidelberg.	
S. R. y Cajal (Sp.) 1852–	*A. Guenée. Histoire naturelle des insectes. Spécies général des Lépidoptères. Paris, 1852-1857.*	
	R. A. Kölliker. Handbuch der gewebelehre des menschen. Leipzig.	

Births	Events	Deaths
	Strawberry root weevil, Brachyrhinus ovatus (*Linn.*), *first reported in United States in Massachusetts.*	
	S. S. Haldeman. Stanbury's exploration and survey of the Great Salt Lake, Utah. Insects. Philadelphia.	
	Green bug, Toxoptera graminum, *described by C. Rondani, Italy.*	
	United States Agricultural Society organized.	
	Small white beans introduced into California.	

1853

Births	Events	Deaths
J. Troop (U. S.) 1853–	Deciduous fruit trees brought into California from Oregon.	*G. Fischer von Waldheim (Russ.) 1771–1853*
W. H. Patton (U. S.) 1853–1918	*Joint worm observed attacking wheat at San José.*	*E. F. Germar (Germ.) 1786–1853*
	Ox warble reported from Nova Scotia by F. Walker.	*E. L. J. H. Boyer de Fonscolombe (Fr.) 1772–1853*
	L. L. Langstroth. On the hive and the honeybee. A beekeeper's manual. Northampton, Pa.	
	Wm. LeBaron described the apple leafhopper as Tettigonia mali (Empoasca).	
	B. Jæger and H. C. Preston. The life of North American insects. New York, 1853–1854. (Providence, R. I., 1855, 208 pp.)	
	E. Candèze and M. F. Chapuis. Catalogue des larves des Coléoptères etc. Liége.	
	S. A. de Marseul. Essai monographique sur la famille des Histérides. Paris, 1853–1862.	
	California State Agricultural Society founded at Sacramento. December.	
	Gadsen Purchase.	

Births	Events	Deaths
	1854	
H. K. Morrison (U. S.) 1854–1885	*Plague of black crickets in Santa Clara Valley, California.*	*Geo. Newport (Engl.) 1803–1854*
Mrs. A. B. Comstock (U. S.) 1854–1930	*Potato tuber moth reported at Santa Cruz, California.*	*F. W. J. Schelling (Germ.) 1775–1854*
G. B. Grassi (It.) 1854–1925	*Red spider noted as a serious pest of fruit trees and other plants in California.*	*C. G. von Mannerheim (Sw.) 1804–1854*
	Grasshopper plague in California.	
	Squash bug first noted in California.	
	Asa Fitch appointed entomologist of the state of New York.	
	Townsend Glover appointed by United States Commissioner of Patents to collect information on seeds, fruits, insects, etc.	
	L. Garreau, France, published experiments with CS_2 in the control of grain weevils. July.	
	E. Emmons. The natural history of New York. Albany.	
	J. T. Lacordaire. Histoire naturelle des insectes. Genre des Coléoptères. 7 vols. Paris, 1854–1863.	
	C. L. Koch. Die pflanzenlause, etc. Nürnberg, 1854–1857.	
	R. Leuckart. Über die micropyle und den feineren bau der schalenhaut bei den insecteneiern. Berlin.	
	First State Agricultural Fair at Sacramento.	
	First Agricultural paper, California Farmer, in state, January.	
	1855	
W. H. Ashmead (U. S.) 1855–1908	*Serious grasshopper outbreak in California.*	*J. Macquart (Fr.) 1794?–1855*
J. D. Putnam (U. S.) 1855–1881	*Western flat-headed borer,* Chrysobothris mali *Horn, recorded*	

Births	Events	Deaths
	as a serious indigenous pest in California by P. S. Strentzel.	
	Cultivation of mulberry trees for silk culture urged in California.	
	J. S. Harbison began beekeeping near Sacramento, California.	
	Asa Fitch attempted to secure the European parasite of the wheat midge from England, but was unsuccessful.	
	Asa Fitch described the pine-leaf scale as Aspidiotus pinifoliæ (Chionaspis).	
	Asa Fitch issued first of his famous 14 reports (1855–1870).	
	H. A. Hagen. Monographie der Termiten. 1855–1870.	
	F. Walker erected the lepidopterous family Cossidæ.	
	Agricultural investigations provided under the United States Commissioner of Patents.	
	Lima beans grown in California.	
	First house erected in Yosemite Valley—later known as Black's Hotel.	
	Completion of the Panama Railroad.	
	Bessemer's process for making steel patented.	
	1856	
Lawrence Bruner (U. S.) 1856–	*Potato tuber moth,* Phthorimæa operculella *(Zeller), noted in markets of San Francisco.*	*T. W. Harris (U. S.) 1795–1856* *N. M. Hentz (U. S.) 1797–1856*
Herbert Osborn (U. S.) 1856–	*J. A. Boisduval. Extrait d'une lettre de M. Lorquin sur la faune de la Californie, etc.*	*J. C. F. Klug (Germ.) 1775–1856*
D. W. Coquillett (U. S.) 1856–1911	*Asa Fitch described the scurfy scale as* Aspidiotus furfurus (Chionaspis).	*P. F. Bouché (Germ.) 1784–1856*
L. Ganglbauer (Germ.) 1856–1912	First French prune cuttings introduced into California by	

Births	Events	Deaths
	Louis and Pierre Pellier, San José.	
	Cotton growing in California attracted attention.	
	Thos. J. White, San Gabriel, introduced first avocadoes into California from Nicaragua.	
	Lady Washington beans introduced into California.	
	J. H. Kaltenbach. Die deutschen phytophagen aus der klasse der insekten, oder versuch einer zusammenstellung der auf Deutschlands pflanzen beobachteten bewohner und ihrer fiende.	
	K. T. E. von Siebold. Wahre parthenogenesis. Leipzig.	
	Neanderthal man discovered in Germany.	
	P. H. Malmsten discovered the parasite protozoan, *Balantidium coli* (Malmsten, 1857), which he believed to be a paramæcium.	
	1857	
L. O. Howard (U. S.) 1857–	*Imported currant worm,* Pteronidea ribesi *(Scopoli), discovered in United States.*	*J. L. C. Gravenhorst (Germ.) 1777–1857*
T. L. Casey (U. S.) 1857–1925	*E. C. A. Candèze. Monographie des Elaterides. 4 vols. Liége, 1857–1863.*	*C. L. Koch (Germ.) –1857*
A. D. Hopkins (U. S.) 1857–	H. C. C. Burmeister. Reise durch die La Plata Staaten. Halle, 1857–1860.	*I. A. M. F. X. Comte (Fr.) 1798–1857*
O. W. Œstlund (U. S.) 1857–	*L. J. Xantus de Vesey collected birds, insects, and plants at Fort Tejon, California. 1857–1858.*	*Carlo Passerini (It.) 1793–1857*
W. A. Locy (U. S.) 1857–1924	F. Leydig. Lehrbuch der histologie des menschen und der tiere. Frankfurt.	
E. E. Bergroth (Finl.) 1857–1925	First English walnuts planted in Los Angeles County.	

Births	Events	Deaths
	Michigan State Agricultural College opened.	
	1858	
L. H. Joutel (U. S.) 1858–1916	*C. R. Osten Sacken. Catalogue of the described Diptera of North America.*	Johannes P. Müller (Germ.) 1801–1858
L. H. Bailey (U. S.) 1858–	*C. H. Boheman described insects collected by the Swedish ship,* Eugenia, *in a voyage around the world in 1851–1858.*	
F. H. Chittenden (U. S.) 1858–1929	*T. W. Harris' collection of 9,758 specimens of insects purchased by the Boston Society of Natural History.*	
Geo. Compere (U. S.) 1858–1928	R. L. C. Virchow. Die cellularpathologie. Berlin.	
H. Garman (U. S.) 1858–	First dates produced in California at Winters, by J. W. Wolfskill.	
F. W. Goding (U. S.) 1858–	The California Culturist, first distinctive agricultural periodical on the Pacific Coast, issued in June.	
B. M. Lelong (U. S.) 1858–1901	Iowa and Minnesota State Agricultural Colleges incorporated.	
John B. Smith (U. S.) 1858–1912	First message over Atlantic Cable, before completed.	
Theodore Roosevelt (U. S.) 1858–1919	Boston public library opened.	
	1859	
W. S. Blatchley (U. S.) 1859–	*J. L. LeConte. Catalogue of Coleoptera of Fort Tejon, California.*	F. H. Alex. von Humboldt (Germ.) 1769–1859
C. P. Gillette (U. S.) 1859–	*J. L. LeConte. The complete writings of Thomas Say on the Entomology of North America. 2 vols. New York.*	*A. G. Dahlbom (Germ.) 1806–1859*
C. W. Leng (U. S.) 1859–	*L. L. Langstroth. A practical treatise on the hive and honey bee. New York.*	*J. F. L. Hausmann (Germ.) 1783–1859*
Jacques Loeb (U. S.) 1859–1924		

BIRTHS	EVENTS	DEATHS
J. T. Monell (U. S.) 1859–1915 *Wm. Schaus (U. S.) 1859–* *H. Jayne (U. S.) 1859–1913* H. Kahl (Sw.) 1859–	*B. Jæger and H. C. Preston. The life of North American insects. Harper Bros., New York.* *H. L. F. de Saussure. Orthoptera nova Americana, 1859–1862.* *C. Gegenbaur. Grundzüge der vergleichenden anatomie. Leipzig.* *V. I. Motschulsky described* Scutellista cyanea. *Entomological Society of Philadelphia organized with J. L. LeConte as first president.* *Beginning of entomological collections in the Academy of Natural Sciences. Philadelphia.* *Colorado potato beetle,* Leptinotarsa 10-lineata *(Say), first associated with injury to potatoes in Nebraska, 1850–1859.* L. Agassiz. Essay on classification. London. C. Darwin. Origin of species. London. Orange tree planted at Bidwell's Bar in Butte County, California. J. C. Lamon planted an apple orchard in the Yosemite Valley. Andrew Murray. Notes on California trees. Edinburgh. University College organized at San Francisco. Invention of the storage or secondary battery by Gaston Plante—France.	

1860

BIRTHS	EVENTS	DEATHS
A. Davidson (Scotl.) 1860–	Building of State Capitol begun at Sacramento. September 24.	*John E. LeConte (U. S.) 1784–1860*

Births	Events	Deaths
F. L. Washburn (*U. S.*) *1860–1927* *Wm. Barnes* (*U. S.*) *1860–1930* *C. F. A. Schæffer* (*U. S.*) *1860–*	*Cabbage butterfly,* Pieris rapæ (*Linn.*), *first discovered in North America at Quebec, Canada.* *Peach twig-borer,* Anarsia lineatella *Zeller, well distributed throughout the United States.* *Bean weevil,* Mylabris obtectus (*Say*), *noted as a pest in the United States.* *J. Curtis. Farm insects. London, 1860, 1862.* *A. M. C. Duméril. Entomologie analytique. Paris.* M. J. S. Schultze first clearly pointed out the nature of protoplasm. Ammonia absorption machine invented.	*Wm. Spence* (*Engl.*) *1783–1860* *M. H. Rathke* (*Germ.*) *1793–1860* *F. Dujardin* (*Fr.*) *1801–1860* *A. M. C. Duméril* (*Fr.*) *1774–1860* *A. A. Retzius* (*Sw.*) *1796–1860* *C. R. Sahlberg* (*Finl.*) *1779–1860*
	1861	
H. Skinner (*U. S.*) *1861–1926* *E. P. Van Duzee* (*U. S.*) *1861–* Wm. Bateson (Engl.) 1861–	*E. T. Cresson. Catalogue of the Tenthredinidæ and Uroceridæ inhabiting North America. Philadelphia.* *J. L. LeConte. Classification of the Coleoptera of North America. Washington.* *H. Loew. Diptera Americæ septentrionalis indigena. 1861–1872.* *H. A. Hagen erected the order Embidina.* Buffalo Society of Natural History founded. C. G. Carus. Natur and idee. Vienna. *J. V. Carus and W. Engelmann. Bibliotheca zoölogica for 1846–1860. Leipzig.* C. Gegenbaur showed that eggs of all vertebrates were single cells. R. Owen. Palæontology. Edinburgh, 1860, 1861.	*E. Ménétriés* (*Russ.*) *1802–1861*

BIRTHS	EVENTS	DEATHS
	Joh. G., Schiödte. De metamorphosi eleutheratorum observationes, Nat. Tidsskr, 13 parts, 1861–1883. Classic on the larvæ of Coleoptera.	
	M. J. S. Schultze established the identity of protoplasm in plants and animals.	
	Abraham Lincoln became president of the United States.	
	First passenger elevators.	
	Civil War began.	
	1862	
E. M. Ehrhorn (U. S.) 1862–	*Asparagus beetle,* Crioceris asparagi (*Linn.*), *observed attacking asparagus in New York.*	*John Curtis (Engl.) 1791–1862*
H. C. Fall (U. S.) 1862–	*H. A. Hagen. Bibliotheca entomologica. 2 vols. Leipzig, 1862–1863.*	*F. W. Hope (Engl.) 1797–1862*
W. T. Davis (U. S.) 1862–	*F. Loew. Monographs of the Diptera of North America. 1861–1862.*	*E. C. Herrick (U. S.) 1811–1862*
Paul Biolley (Switz.) 1862–1908	*E. T. Cresson. Catalogue of the described species of North American Hymenoptera. 1862–1863.*	
	J. L. LeConte erected the coleopterous family Hydrophilidæ.	
	J. G. Morris. Synopsis of the Lepidoptera of North America.	
	Flint edition of Harris. Insects injurious to vegetation. Boston.	
	United States Department of Agriculture formally organized.	
	Morrill Act donating public lands to create land-grant colleges of agriculture and mechanical arts.	
	First flour exported from California.	
	Four hundred and fifty acres of cotton plants in Kern and Los Angeles counties.	

Births	Events	Deaths
	1863	
C. L. Marlatt (U. S.) 1863–	*Townsend Glover appointed entomologist of United States Department of Agriculture.*	*Ebenezer Emmons (U. S.) 1799–1863*
H. E. Summers (U. S.) 1863–	*Proceedings of the Entomological Society of Philadelphia appeared. Volume 1.*	
A. P. Morse (U. S.) 1863–	*Entomological Society of Canada founded.*	
C. H. T. Townsend (U. S.) 1863–	*C. Stål. Monograph of the Chrysomelidæ of America. 1863–1865.*	
W. T. Clarke (U. S.) 1863–1929	*F. M. Brauer. Monographie der Œstriden.*	
A. Berlese (It.) 1863–1927	*R. M'Lachlan. Notes on North American Phryganeidæ. London.*	
	W. H. Brewer observed the pupæ of Ephydra hians *Say, on the shores of Mono Lake, California.*	
	T. H. Huxley. Evidence as to Man's place in nature.	
	C. Lyell. The geological evidences of the antiquity of Man.	
	First orange trees, seedlings, planted at Plano, Tulare County, California, by D. Gibbons.	
	J. N. Demarquay first saw the embryos of filaria.	
	The Emancipation Proclamation abolished slavery in United States.	
	Battle of Gettysburg.	
	1864	
Wm. Beutenmüller (U. S.) 1864–	*J. S. Harbison invented the California hive.*	
A. B. Cordley (U. S.) 1864–	*A. S. Packard. The humblebees of New England and their parasites.*	
J. L. Hancock (U. S.) 1864–1922	*Insect collections of Coleoptera of the Melsheimers and Ziegler pur-*	

BIRTHS	EVENTS	DEATHS
Wm. Lochhead (Can.) 1864–1927 *W. D. Kearfott (U. S.) 1864–1917* *M. V. Slingerland (U. S.) 1864–1909* *C. M. Weed (U. S.) 1864–* C. R. Orcutt (U. S.) 1864–1929	*chased by the Cambridge Museum of Comparative Zoölogy.* *Colorado potato beetle first noted in the potato fields of Illinois.* *J. R. Schiner erected the dipterous family Cecidomyiidæ.* *First record of the harlequin cabbage bug,* Murgantia histrionica *(Hahn), in the United States in Texas.* *Zoölogical Record started in London.* Yosemite Valley and Mariposa Big Tree Grove granted to California by Act of Congress—June 30 (approved). (Accepted by California State Legislature, April 2, 1866.) Modoc Indian War began in California.	
	1865	
F. Knab (Germ.) 1865–1918 *W. M. Wheeler (U. S.) 1865–* *C. W. Woodworth (U. S.) 1865–*	*The Practical Entomologist, founded by the American Entomological Society at Philadelphia. First journal devoted to economic entomology in the United States.* *L. Pasteur's investigations of pebrine in silkworms. 1865–1870.* L. Agassiz made a scientific expedition up the Amazon. Close of the Civil War. A. Lincoln began second term as president and was assassinated.	*W. S. MacLeay (Engl.) 1792–1865* *H. E. Straus-Durckheim (Germ.) 1790–1865* *H. R. Schaum (Germ.) 1819–1865* *Leon Dufour (Fr.) 1780–1865* Abraham Lincoln (U. S.) 1809–1865
	1866	
J. M. Aldrich (U. S.) 1866– *G. A. Coleman (U. S.) 1866–*	*F. Walker. Insects in John K. Lord's Naturalist in Vancouver Island and British Columbia.* *B. D. Walsh appointed state entomologist of Illinois.*	*C. H. G. von Heyden (Germ.) 1793–1866* *C. J. B. Amyot (Fr.) 1799–1866*

Births	Events	Deaths
H. G. Dyar (*U. S.*) *1866–1929* *H. T. Fernald* (*U. S.*) *1866–* *J. S. Hine* (*U. S.*) *1866–* *S. J. Hunter* (*U. S.*) *1866–* *W. G. Johnson* (*U. S.*) *1866–1908* *T. H. Morgan* (*U. S.*) *1866–* *H. F. Wickham* (*U. S.*) *1866–* *E. A. Bischoff* (*U. S.*) *1866–1923*	*E. Mulsant. Monographie des Coccinellides. 3 parts. 1866–1870.* E. H. Hæckel applied the doctrine of evolution in his General Morphology. L. Pasteur. Études sur le vinaigre. Paris. R. Owen. On the anatomy of vertebrates. London. J. Mendel's papers on heredity published at Brünn. 1866–1867. Webster Brothers, Stockton, California, acquired the patent rights of the Baxter gang plow. Atlantic cable completed. Discovery of open-hearth steel process.	
	1867	
P. A. Glenn (U. S.) 1867– *S. A. Johnson* (*U. S.*) *1867–* *V. L. Kellogg* (*U. S.*) *1867–* *E. G. Lodeman* (*Switz.*) *1867–1896* *H. A. Morgan* (*U. S.*) *1867–* *H. A. Surface* (*U. S.*) *1867–* *C. Kertesz* (*Hung.*) *1867–1922*	*H. A. Hagen accepted position in the Cambridge Museum Comparative Zoölogy, Harvard.* *American Entomological Society succeeded the Entomological Society of Philadelphia.* *Transactions of the American Entomological Society started.* *Byron Markham claimed to have used Paris green to destroy the Colorado potato beetle in Michigan.* Joseph Lister applied Pasteur's theories to the practice of surgery. Raisins produced at Davisville and Woodland, California. Alaska purchased by the United States from Russia.	*C. Zimmermann* (*U. S.*) *1800–1867* *Charles Coquerel* (*Hol.*) *1822–1867* *O. G. Costa* (*It.*) *1787–1867*
	1868	
N. Banks (*U. S.*) *1868–*	*Argentine ant was described as* Hypoclinea humilis *by G. Mayr*	*C. H. Boheman* (*Sw.*) *1796–1868*

Births	Events	Deaths
M. Bezzi (It.) *1868–1927*	*from workers taken in 1866 at Buenos Ayres.*	*J. van der Hœven (Hol.)* *1801–1868*
W. E. Britton (U. S.) *1868–*	*Cabbage butterfly,* Pieris rapæ *(Linn.), first reported in New York.*	
F. E. Brooks (U. S.) *1868–*	*American Entomologist and Botanist began.*	
E. P. Felt (U. S.) *1868–*	*Canadian Entomologist started.*	
H. A. Gossard (U. S.) *1868–1925*	*C. V. Riley appointed state entomologist of Missouri.*	
Ralph Hopping (U. S.) *1868–*	*S. H. Scudder. Catalogue of Orthoptera of North America described previous to 1867.*	
A. D. MacGillivray (U. S.) *1868–1924*	*W. H. Edwards. The butterflies of North America. 3 vols. Philadelphia, New York, 1868–1897.*	
J. G. Needham (U. S.) *1868–*	*V. A. Signoret's papers on Coccidæ, 1868–1876.*	
	M. Gemminger and E. von Harold. Catalogus Coleopterorum, 12 vols., 1868–1876.	
	C. Darwin. Animals and plants under domestication.	
	E. H. Hæckel. Naturlische schöpfungsgeschichte. Berlin.	
	First wine exported from California.	
	First practical typewriter invented by C. L. Sholes, United States.	

1869

Births	Events	Deaths
E. W. Berger (U. S.) *1869–*	*The cottony cushion scale,* Icerya purchasi *Mask., was introduced into Menlo Park, California, on acacia from Australia, about 1869.*	*Benedict Jæger (U.S.)* *1789–1869*
H. Bird (U. S.) *1869–*	*V. A. Signoret described the aspidistra scale as* Chionaspis aspidistræ *and the greedy scale as* Aspidiotus camelliæ.	*Charles Aubé (Fr.)* *1802–1869*
A. G. Böving (Denm.) *1869–*		*C. G. Carus (Germ.)* *1789–1869*
F. M. Jones (U. S.) *1869–*		*J. E. Purkinje (Boh.)* *1787–1869*

Births	Events	Deaths
R. H. Petit (U. S.) 1869–	*E. Newman described the purple scale,* Coccus becki (Lepidosaphes) *and named it after Richard Beck.*	
C. B. Thompson (U. S.) 1869–	*A. S. Packard named the Glover's scale,* Coccus gloveri (Lepidosaphes) *after Townsend Glover.*	
E. C. Van Dyke (U. S.) 1869–	*G. Targionia Tozzetti named the Parlatoria date scale,* Coccus blanchardi (Parlatoria) *after E. Blanchard.*	
H. Champion (Engl.) 1869–1924	*A. S. Packard. Guide to the study of insects.*	
F. C. Pratt (Engl.) 1869–1911	*L. Provancher began publishing Le Naturaliste Canadien.*	
	Gypsy moth, Porthetria dispar *(Linn.), introduced into Massachusetts about this time.*	
	J. Lubbock defined the order Thysanura in its present restricted sense (Leach, 1815).	
	State Capitol Building at Sacramento first occupied, November 26.	
	English walnut orchard planted at Capistrano by J. R. Congdon.	
	Air brake invented by Geo. Westinghouse, Jr., United States.	
	Trans-continental railroad finished, May 10.	

1870

E. D. Ball (U. S.) 1870–	*A. Kellogg noted scale insects on shade trees in California and advised spraying with potash solutions.*	*B. D. Walsh (U. S.) 1808–1870*
A. Busck (Denm.) 1870–	*San José scale,* Aspidiotus perniciosus *Comst., introduced into California at San José.*	*J. T. Lacordaire (Fr.) 1801–1870*
L. Cæsar (Can.) 1870–		*J. P. Rambur (Fr.) 1801–1870*

Births	Events	Deaths
G. W. Herrick (*U. S.*) *1870–*	*Woolly apple aphis,* Eriosoma lanigera (*Hausm.*), *first noted in California.*	
J. F. Illingworth (*U. S.*) *1870–*	*Red spider reported injurious to almond trees in California.*	
O. A. Johannsen (*U. S.*) *1870–*	*Cabbage butterfly,* Pieris rapæ (*Linn.*), *reported in California.*	
A. L. Quaintance (*U. S.*) *1870–*	*Article on cheese skipper,* Piophila casei (*Linn.*), *published in American Entomologist by X. A. Willard.*	
F. W. Nunenmacher (*U. S.*) *1870–*	*A. J. Cook first to experiment with crude carbolic acid emulsion in United States.*	
F. H. Wooley Dod (*Can.*) *1870–1919*	*V. A. Signoret named the Mediterranean fig scale* Mytilaspis ficus (Lepidosaphes).	
	A. S. Packard reported the greenhouse thrips, Heliothrips hæmorrhoidalis (*Bouché*), *injurious to greenhouse tulips in East.*	
	C. Stål. Enumeratio Hemipterorum. 5 pts. Stockholm, 1870–1876.	
	A. R. Wallace. Contributions to the theory of natural selection. London.	
	American Museum of Natural History founded in New York.	
	Farmers' Institutes of Massachusetts organized.	
	Entomological Society of Ontario founded in Canada.	
	California Horticulturist founded at San Francisco (1870–1880).	
	Experimental culture of tea in Napa and Eldorado counties, California.	
	Blossom Rock removed from San Francisco Bay. August 23.	

Births	Events	Deaths
	1871	
R. W. Doane (*U. S.*) *1871–* *J. W. Folsom* (*U. S.*) *1871–* *J. E. Guthrie* (*U. S.*) *1871–*	Extensive silkworm boom throughout California—large shipment of eggs from Japan. 135,000 cards of silkworm eggs valued at $675,000 arrived in California from Japan. Silk association of Davisville, California, packed 1,000 ounces of silkworm eggs for exportation to France. C. L. Dimon planted 10,000 mulberry trees at Grass Valley, California, preparatory to entering the silk business. California cochineal found to be of good quality. Serious grasshopper invasions in the central and southern parts of California. Wireworms reported injurious to wheat near Chico, California. *False chinch bug,* Nysius ericæ (*Schil.*), *swarmed in Butte County, California, July.* *Pacific Rural Press called attention to the grape phylloxera in France.* *Lord Walsingham collected Lepidoptera in Oregon and California, 1871–1872.* C. Darwin. The descent of man. London. Sugar beet trials in the Salinas Valley, California. Introduction of the navel orange from Bahia, Brazil, into Florida, urged. Poppy culture for opium on trial in several parts of central California. Turkish (Persian) melons produced at Oroville, California.	*J. T. C. Ratzeburg* (*Germ.*) *1801–1871* *I. G. Vosnesensky* (*Russ.*) *1816–1871* *V. I. Motschulsky* (*Russ.*) *1810–1871*

BIRTHS	EVENTS	DEATHS
	Three avocado trees introduced into California from Mexico by R. B. Ord.	
	Cherimoya introduced into California by R. B. Ord.	
	Reclamation of overflow and swamp lands important issue in California.	
	1872	
C. F. Baker (*U. S.*) *1872–1927*	*Legislative bills to aid silk culture in California defeated.*	*C. T. Robinson* (*U. S.*) *1838–1872*
H. A. Ballou (*U. S.*) *1872–*	*Codling moth first discovered in California.*	*F. J. Pictet* (*Switz.*) *1809–1872*
A. N. Caudell (*U. S.*) *1872–*	*Armyworms serious pests in California.*	*A. Brullé* (*Fr.*) *1809–1872*
Mabel Colcord (*U. S.*) *1872–*	*Tomato worm,* Protoparce sexta (*Johan.*), *a serious pest in parts of California.*	
G. H. Griswold (*U. S.*) *1872–*	*W. P. Gibbons gave lecture on scale insects at University of California—brown apricot and other scales described. Wednesday, June 26.*	
W. J. Fox (*U. S.*) *1872–*	*Five species of* Aspidiotus *found in orchards of California.*	
Trevor Kincaid (*U. S.*) *1872–*	*R. H. Stretch reported the cottony cushion scale,* Icerya purchasi *Mask., at Menlo Park, California.*	
	C. V. Riley first took notice of cottony cushion scale in California.	
	Red scale, Chrysomphalus aurantii (*Mask.*), *introduced into San Gabriel Valley, southern California.*	
	Tarnished plant bug, Lygus pratensis *Linn., injurious to cotton, alfalfa, and other crops in the San Joaquin Valley, California.*	
	Polycaon confertus *Lec., observed attacking grapevines in Napa County.*	

Births	Events	Deaths
	Scab mite epizoötic serious on horses and less so on cattle in San Francisco in 1872–1875.	
	Petroleum recommended as a specific remedy for control of bites and stings of insects.	
	Charcoal and lime recommended for root-infesting insects.	
	A. S. Packard first called attention to damage of the onion thrips, Thrips tabaci *Lind., in Massachusetts, where it had been noticed for some 15 years.*	
	Peach twig borer, Anarsia lineatella *Zeller, first recorded in the United States in Kentucky and Maryland.*	
	Pear leaf blister mite, Eriophyes pyri (*Pagen.*), *first recorded in United States in Maryland.*	
	P. R. Uhler. Hemiptera of the Western Territories of the United States.	
	W. LeBaron colonized Aphelinus mali *LeB. in various parts of Illinois to destroy the oyster shell scale,* Lepidosaphes ulmi (*Linn.*). (*Proved to be a parasite of the woolly apple aphis and other aphids.*)	
	L. Provancher described the clover leafhopper as Bythoscopus sanguinolenta (Agallia).	
	C. Stål described Say's plant bug, Chlorochroa sayi.	
	A. J. Ebell. Structure and classification of insects. New York.	
	H. T. Stainton. Tineidæ of North America.	
	C. P. Zeller. North American Microlepidoptera, 1872, 1873, 1875.	
	Brooklyn Entomological Society organized by C. Fuchs and F. G. Schaupp.	

Births	Events	Deaths
	L. Agassiz lectured before California Academy of Sciences, San Francisco. September.	
	Anton Dohrn's Zoölogical Station at Naples founded.	
	Curl leaf serious on peaches in parts of California—real cause unknown.	
	Twenty pounds of opium produced in the Riverside Colony, California.	
	Large plantings of Languedoc almond in California.	
	Rice produced experimentally in Orange County—crop a failure in Los Angeles County.	
	One hundred-ton crop of chicory raised around Stockton.	
	C. R. Workman, Los Angeles, originated the Eureka lemon from a single seed received from Hamburg, Germany.	
	At San Diego Mission there were still growing 300 olive trees from 80 to 100 years old, originally planted by the Spanish.	
	The Buena Vista vineyard largest in California, comprised 500 acres of vines, as well as 3,000 mulberry trees.	
	H. C. Shaw perfected the Stockton gang plow.	
	Modoc Indian War in California.	
	Great fire in Boston.	

1873

A. F. Burgess (U. S.) 1873–	*San José scale noted in California.*	*F. E. Melsheimer (U. S.) 1782–1873*
B. C. Cady (U. S.) 1873–	*San Francisco Sericultural Association formed in San Francisco with capital stock of $400,000.*	*P. J. M. Lorquin (Fr.) 1797–1873*
R. A. Cooley (U. S.) 1873–		

Births	Events	Deaths
G. A. Dean (U. S.) 1873–	*J. S. Harbison shipped a carload of section honey from San Diego County to Chicago.*	*Louis Agassiz (U. S.) 1807–1873*
J. Kotinsky (Russ.) 1873–	*E. B. Mastick, Alameda, practiced killing the woolly apple aphis on limbs by painting them with kerosene.*	
E. G. Titus (U. S.) 1873–	*Scab mite epizoötic continued serious on horses and cattle in San Francisco.*	
W. R. Walton (U. S.) 1873–	*G. H. Horn erected the coleopterous family Histeridæ.*	
	C. V. Riley and J. E. Planchon introduced the mite, Tyroglyphus phylloxeræ *Riley, an enemy of the grape phylloxera in America, into France.*	
	Cabbage curculio, Ceutorhynchus rapæ *Gyll., became established in the United States, in Massachusetts, about 1873.*	
	Cyrus Thomas. Synopsis of the Acridiidæ of North America.	
	A. S. Packard. Our common insects.	
	G. R. Crotch. Revision of the Coccinellidæ and check list of the Coleoptera of America, north of Mexico.	
	P. R. Uhler. List of Hemiptera of the region west of the Mississippi River, etc.	
	Sir John Lubbock. Monograph of the Collembola and Thysanura. Erected the order Collembola.	
	H. Loew described the Mexican orange maggot as Trypeta ludens (Anastrepha).	
	Two navel orange trees taken to Riverside by Eliza Tibbets from the United States Department of Agriculture.	
	Muscat vines first brought to the Fresno district.	

Births	Events	Deaths
	Jute seed distributed in California by United States Commissioner of Agriculture.	
	Burbank potato originated in California.	
	Between 1,500 to 2,000 acres of cotton planted in Merced County, California.	
	First export of cotton from California—22,886 pounds.	
	Buildings of the College of Agriculture, University of California, erected and Hilgard chosen Professor of Agriculture.	
	O. Obermeier discovered the spirochæte of relapsing fever.	
	1874	
P. J. Parrott (*U. S.*) *1874–*	*Codling moth larvæ first found in California in apples exhibited at the Stockton Fair. October 2.*	*Francis Walker* (*Engl.*) *1809–1874*
J. R. Watson (*U. S.*) *1874–*	*Black scale,* Saissetia oleæ (*Bern.*), *first observed as pest of olives at Santa Barbara, California.*	*G. R. Crotch* (*U. S.*) *1842–1874*
	Grape phylloxera, Phylloxera vitifoliæ *Fitch, first observed in California near Sonoma.*	*G. A. W. Herrich-Schæffer* (*Germ.*) *1799–1874*
	Potota tuber moth, Phthorimæa operculella (*Zeller*), *described from Algeria by J. A. Boisduval.*	*J. W. Zetterstedt* (*Germ.*) *1785–1874*
	Potato tuber moth, a pest in southern California.	*F. E. Guèrin-Menéville* (*Fr.*) *1799–1874*
	Pebrine disease of silkworm common in California.	
	Many wild bee trees found in Shasta and Siskiyou counties—one boy found 17 trees in one month in the latter county.	
	Foul brood of bees pronounced incurable in England.	

Births	Events	Deaths
	Caterpillars of white-lined sphinx, Celerio lineata (*Fabr.*), *injurious to grapevines in Sonoma and Solano counties.*	
	Insect producing the jumping galls of valley oak described by H. Edwards as Diplobius saltatorius (Neuroterus).	
	J. H. Comstock appointed instructor in entomology at Cornell University.	
	Cambridge Entomological Club organized by H. A. Hagen.	
	Psyche—First volume appeared.	
	Colorado potato beetle reached the Atlantic Coast in its eastward migrations.	
	Reports of the occurrence of the Buffalo carpet beetle, Anthrenus scrophulariæ (*Linn.*), *in the United States.*	
	C. P. Zeller. Lepidoptera der Westküste Amerikas.	
	L. Provancher. Faune entomologique du Canada. 3 vols. 1874–1879.	
	Orange grove of J. W. Wolfskill, Los Angeles, first commercial grove to become productive in California in 1874. This orchard occupied the present site of the Southern Pacific Railroad depot and yards.	
	J. F. P. MacConnell in India and W. MacGregor in Mauritius independently discovered the Chinese human liver fluke.	
	Brown Durra sorghum introduced into California from Egypt.	
	Gilroy, California, tobacco factory employed 125 men.	

BIRTHS	EVENTS	DEATHS
	Six woolen mills in California.	
	Vivisection—a lively topic in England and Europe.	
	Remington typewriter—the first practical one in America.	
	1875	
R. P. Currie (U. S.) 1875–	*Grape phylloxera a pest in Sonoma County, California.*	*Charles Lyell (Engl.) 1797–1875*
S. B. Doten (U. S.) 1875–	*E. W. Hilgard published first record of grape phylloxera in California and warned against its spread on cuttings. —First published entomological work of the College of Agriculture, University of California.*	
C. Fowler (U. S.) 1875–	*Grasshopper invasions in many parts of California.*	
W. D. Hunter (U. S.) 1875–1925	*Pear slug,* Eriocampoides limacina *Retz., a pest of pears in Santa Clara Valley, California.*	
J. A. Nelson (U. S.) 1875–	*Bee moth,* Galleria mellonella *(Linn.), noted in beehives of California.*	
A. G. Ruggles (U. S.) 1875–	*Warning concerning menace of Colorado potato beetle to California.*	
R. E. Snodgrass (U. S.) 1875–	*Almond mite,* Bryobia prætiosa *Koch, common in various parts of California.*	
L. H. Weld (U. S.) 1875–	*Larvæ of ox warble taken on American bison in Colorado.*	
Arthur Gibson (Can.) 1875–	*C. R. Osten Sacken visited California. 1875–1876.*	
N. Criddle (Engl.) 1875–	*H. A. Hagen. Synopsis of the Odonata of America.*	
	Bulletin, United States Geological and Geographical Survey of the Territories.—F. V. Hayden. 4 vols. Washington, D. C., 1875–1878.	
	S. A. de Saussure. Synopsis of American wasps.	

Births	Events	Deaths
	C. Darwin. Insectivorous plants. London.	
	Connecticut Agricultural Experiment Station organized.	
	F. Lösch discovered the dysentery amœba.	
	Wine—9,000,000 gallons valued at $4,000,000, exported from California.	

1876

Births

G. M. Bentley (U. S.) 1876–

M. W. Blackman (U. S.) 1876–

E. C. Cotton (U. S.) 1876–

W. B. Herms (U. S.) 1876–

W. E. Hinds (U. S.) 1876–

A. C. Morgan (U. S.) 1876–

E. M. Patch (U. S.) 1876–

W. A. Riley (U. S.) 1876–

H. J. Quayle (Isle of Man) 1876–

Events

End of effort to build a silkworm egg trade in California.

Codling moth observed attacking pears in Marysville, California.

Oyster shell scale, Lepidosaphes ulmi *(Linn.), well distributed in California.*

Cottony cushion scale reached Ventura County.

E. W. Hilgard urged interest in grape phylloxera situation. California.

An attempt to secure state aid to stamp out phylloxera in Sonoma County, failed in the legislature.

Cabbage aphis, Brevicoryne brassicæ *(Linn.), noted at Bodega Bay, California.*

Tent caterpillars serious pests of fruit trees in the Santa Clara Valley, California.

Sweet potato weevil, Cylas formicarius *(Fabr.), discovered in United States at New Orleans.*

Rhizoglyphus root mite blamed for killing orange and lemon trees in Los Angeles County.

J. L. LeConte took first specimens of clover root curculio, Sitona hispidulus *(Fabr.), on Long Island, New York.*

Deaths

Wm. LeBaron (U.S.) 1814–1876

Daniel Ziegler (U.S.) 1804–1876

Edward Newman (Engl.) 1801–1876

J. H. Kaltenbach (Germ.) 1807–1876

Karl E. von Baer (Germ.) 1792–1876

BIRTHS	EVENTS	DEATHS
	Xanthate of potash recommended for the control of phylloxera in Europe.	
	A. J. Cook. Manual of the apiary. Chicago.	
	A. S. Packard. Monograph of the geometrid moths.	
	J. L. LeConte and Geo. H. Horn. Rhyncophora of North America.	
	A. R. Wallace. The geographical distribution of animals. London.	
	One hundred cranberry plants set out for trial in Kern County.	
	J. Tyndall published on spontaneous generation.	
	T. Bancroft discovered the adult filaria.	
	Robert Koch's investigations, showing the causal relation between anthrax and a specific bacillus, marked the beginnings of modern bacteriology.	
	Bell invented the telephone. United States.	
	Centennial Exposition at Philadelphia.	
	1877	
T. J. Headlee (U. S.) 1877–	*Devastating grasshopper described as a new species,* Melanoplus devastator, *by Scudder.*	*J. P. Kirtland (U. S.) 1793–1877*
W. C. O'Kane (U. S.) 1877–	*G. P. Rixford recorded* Polycaon confertus *Lec. attacking twigs of olive trees in Sonoma County.*	
C. E. Sanborn (U. S.) 1877–	*The Jerusalem cricket,* Stenopelmatus *sp., from California first described and figured as mole cricket by S. S. Rathvon.*	
F. Sherman, Jr. (U. S.) 1877–	*Cottony cushion scale a serious pest of acacia trees in Marin County, California.*	
E. B. Williamson (U. S.) 1877–	*Moth-trap beehive used in California to exclude beemoth.*	
J. McDunnough (Can.) 1877–		

Births	Events	Deaths
H. Maxwell Lefroy (Engl.) 1877–1925	*Eucalyptus proven safe for honeybees in California.*	
	Putnam named Putnam's scale, Diaspis ancylus (Aspidiotus).	
	Pistol case bearer first observed in Pennsylvania.	
	Fruit tree barkbeetle, Scolytus rugulosus *Ratz., first noted in the United States.*	
	F. M. van der Wulp erected the dipterous family Bombyliidæ.	
	A. J. Cook demonstrated the use of kerosene emulsion in Michigan.	
	The United States Entomological Commission appointed.	
	C. R. Osten Sacken. Western Diptera.	
	Rural Californian established in Los Angeles.	
	S. A. Forbes founded the Illinois Laboratory of Natural History.	
	T. A. Garey introduced the Eureka lemon in southern California—It was originated by C. R. Workman.	
	Lima beans became a commercial crop in California.	

1878

Births	Events	Deaths
H. E. Burke (U. S.) 1878–	*Western flat-headed borer,* Chrysobothris mali *Horn, noted as a pest to fruit trees in Ventura County.*	*Carl Stål (Sw.) 1833–1878*
J. D. Detwiler (Can.) 1878–	*Red scale,* Chrysomphalus aurantii *(Mask.), well established in citrus orchards of the San Gabriel Valley of southern California.*	
W. S. Fisher (U. S.) 1878–	*First meeting of viticulturists at Sonoma to discuss phylloxera situation with E. W. Hilgard.*	
A. L. Melander (U. S.) 1878–		
Wilmon Newell (U. S.) 1878–		

Births

E. F. Phillips (*U. S.*) *1878–*

E. D. Sanderson (*U. S.*) *1878–*

D. L. Van Dine (*U. S.*) *1878–*

J. L. Webb (*U. S.*) *1878–*

Events

E. J. Wickson of Pacific Rural Press offered to make free examinations of grape roots for phylloxera.

Eggs of clover mite, Bryobia prætiosa *Koch, first noted in United States by Theo. Pergande at Washington, D. C., on elm.*

Pyrethrum boom in California—considerable areas planted.

Paris green first used for control of codling moth in New York by J. S. Woodward and for the Colorado potato beetle.

Wm. Maskell described the cottony cushion scale as Icerya purchasi, *and the red scale as* Aspidiotus aurantii (Chrysomphalus).

Clover root borer, Hylastinus obscurus *Marsham, first noted in the United States in central New York.*

G. V. Riley first appointed entomologist, United States Department of Agriculture.

L. O. Howard became assistant to C. V. Riley in United States Department of Agriculture.

First Report of the U. S. Entomological Commission.

V. T. Chambers. Tineina and their food plants.

F. H. Strecker. Butterflies and moths of North America.

Bulletin Brooklyn Entomological Society begun.

Zoölogical Anzeiger, Leipzig, appeared.

Journal Royal Microscopical Society, London, appeared.

Organism causing fire blight or pear blight described by T. J. Burrill.

Deaths

Births	Events	Deaths
	First telephone exchange established.	
	1879	
C. R. Crosby (*U. S.*) *1879–*	*San José scale known as "small round black scale" in the Santa Clara Valley, California.*	*Asa Fitch* (*U. S.*) *1809–1879*
R. D. Glasgow (*U. S.*) *1879–*	*Red scale a serious pest in southern part of California.*	*John G. Morris* *1803–1879*
F. Z. Hartzell (*U. S.*) *1879–*	*Codling moth reported attacking fruit at Newcastle, California.*	*W. W. Saunders* (*Engl.*) *1809–1879*
H. E. Hodgkiss (*U. S.*) *1879–*	*Matthew Cooke became interested in codling moth control in California.*	*H. Loew* (*Germ.*) *1807–1879*
C. H. Kennedy (*U. S.*) *1879–*	*Grasshoppers destructive in the Sierra foothills, California.*	*J. A. Boisduval* (*Fr.*) *1799–1879*
F. E. Lutz (*U. S.*) *1879–*	*Flooding the only measure recommended for the control of the grape phylloxera in California.*	*J. C. Rondani* (*It.*) *1807–1879*
D. Moulton (*U. S.*) *1879–*	Diabrotica soror *Lec., first observed as a pest in many parts of central and northern California.*	
G. I. Reeves (*U. S.*) *1879–*	*Fuller's rose weevil* Pantomorus godmani (*Crotch*), *first noted as pest in southern part of California.*	
A. F. Satterwait (*U. S.*) *1879–*	*Plum curculio,* Conotrachelus nenuphar (*Hbst.*), *erroneously reported in California.*	
W. J. Schœne (*U. S.*) *1879–*	*Larvæ of* Prionus californicus *Mots., recorded attacking walnuts in California by H. H. Behr.*	
C. T. Vorhies (*U. S.*) *1879–*	*Corn earworm observed at Newcastle, California.*	
W. W. Yothers (*U. S.*) *1879–*	*Felix Gillet demonstrated that the cocoons of the native California lilac moth could not be reeled for use as silk.*	
	Jointworm reported attacking wheat at Healdsburg, California.	
	Eggs of Bryobia prætiosa *Koch taken on apple at San Francisco, California, sent to H. Garman by E. J. Wickson.*	

Births	Events	Deaths
	Cyrus Thomas. Aphididæ of Illinois.	
	S. H. Scudder. Catalogue of scientific serials.	
	W. M. Maskell began publishing descriptions of Coccidæ.	
	O. Salvin and F. D. Godman issued first part of Biologie Centrali-Americana.	
	J. H. Fabre. Souvenirs entomologiques. 10 vols. 1879–1908.	
	North American Entomologist founded by A. R. Grote.	
	P. Manson discovered the rôle of the mosquito in the development of filarial worms.	
	California State Constitutional Convention.	
	Zoölogischer Jahresbericht, Leipzig.	
	C. G. P. de Laval invented the centrifugal cream separator—Sweden.	

1880

Births	Events	Deaths
E. A. Back (U. S.) 1880–	*Act for promotion of viticulture in California approved.*	*S. S. Haldeman (U. S.) 1812–1880*
J. W. Chapman (U. S.) 1880–	*Board of State Viticultural Commissioners of California appointed by Gov. G. C. Perkins.*	*Jacob Boll (U. S.) 1828–1880*
J. C. Crawford (U. S.) 1880–	*Assembly bill to provide for extermination of insect pests in orchards and vineyards defeated. California.*	*F. L. Laporte de Castelnau (Fr.) 1810–1880*
R. A. Cushman (U. S.) 1880–	*E. W. Hilgard published pamphlet on phylloxera.*	*Theodor Hartig (Germ.) 1805–1880*
A. B. Gahan (U. S.) 1880–	*J. H. Comstock in California to study scale insects—arrived in July.*	*E. A. H. Kiesenwetter (Germ.) 1820–1880*
C. Heinrich (U. S.) 1880–	*Grasshoppers serious in California and Nevada.*	*E. Mulsant (Fr.) 1797–1880*
H. E. Jaques (U. S.) 1880–	*Angular-winged katydid eggs observed in Tuolumne County.*	*A. Guenée (Fr.) 1809–1880*
E. G. Kelly (U. S.) 1880–		

Births	Events	Deaths
E. A. McGregor (U. S.) *1880–*	*Strawberry aphis,* Myzus fragæfolii *Ckll., first recorded in California.*	
A. W. Morrill (U. S.) *1880–*	*Imported currant borer,* Ægeria tipuliformis *(Linn.), reported in California by C. H. Dwinelle.*	
J. G. Sanders (U. S.) *1880–*	*Pacific peach tree borer,* Ægeria opalescens *Hy. Edw., reported as a pest in Santa Clara Valley.*	
J. S. Wade (U. S.) *1880–*	*Grape leafhopper,* Erythroneura comes *(Say), abundant in California.*	
A. G. Hammar (Sw.) *1880–1913*	*Jointworms injuring wheat at San José.*	
	Citrus mealybug, Pseudococcus citri *(Risso), first noted in California.*	
	Aphelinus fuscipennis *How., reared from San José scale in the Santa Clara Valley.*	
	J. S. Harbison built first honey house in California in San Diego County.	
	European Phylloxera Congress.	
	New York Entomological Club organized.	
	Second Report, U. S. Entomological Commission.	
	Lord Walsingham. Pterophoridæ of California.	
	J. H. Comstock named walnut scale, Aspidiotus juglans-regiæ, *the San José scale,* A. perniciosus, *the grape scale,* A. uvæ, *and the chaff scale,* Parlatoria pergandei, *the last after Theo. Pergande.*	
	A. R. Wallace. Island life. London.	
	F. M. Balfour. Comparative Embryology. London.	
	Robt. Manning. History of the Massachusetts Horticultural Society. Gives early history of	

Births	Events	Deaths
	horticulture in North America.	
	G. P. Rixford, through the San Francisco Bulletin, introduced 70,000 Smyrna fig cuttings into California for distribution.	
	Soft shell English walnut, originated by Joseph Sexton at Goleta, came into note.	
	C. L. A. Laveran, French physician, discovered the malaria parasite.	
	C. J. Eberth discovered the typhoid bacillus.	
	Immigration treaty with China.	
	Johnson grass established in various parts of California.	
	1881	
T. C. Barber (*Engl.*) *1881–*	*Matthew Cooke addressed the First Annual Horticultural Convention at Sacramento, December 6 and 7, on insect pests.*	*J. D. Putnam* (*U. S.*) *1855–1881*
G. C. Crampton (*U.S.*) *1881–*	*California Board of State Horticultural Commissioners organized with C. H. Dwinelle as president.*	*G. Koch* (*Germ.*) *1807–1881*
D. E. Fink (*U. S.*) *1881–*	*Chas. A. Wetmore appointed Chief Executive Viticultural and Health Officer of California.*	*M. de Chaudoir* (*Russ*) *1816–1881*
W. D. Funkhouser (*U. S.*) *1881–*	*Matthew Cooke appointed first Chief Executive Horticultural and Health Officer of California.*	
B. N. Gates (*U. S.*) *1881–*	Duties and powers of Board of State Viticultural Commissioners of California enlarged by act of legislature.	
J. S. Houser (*U. S.*) *1881–*	*Board of State Viticultural Commissioners considered propagating beneficial insects.*	
N. E. McIndoo (*U. S.*) *1881–*	*Board of State Viticultural Commissioners petition the regents of University of California for a Professorship of Entomology.*	
R. Matheson (*U. S.*) *1881–*		
J. H. Merrill (*U. S.*) *1881–*		
H. Notman (*U. S.*) *1881–*		
E. E. Scholl (*U. S.*) *1881–*		

Births	Events	Deaths
H. L. Viereck (U. S.) 1881–	County Boards of Horticultural Commissioners created, March 14.	
	Sacramento County first to organize under the County Horticultural Commissioner Act of 1881.	
	Alex. Craw exhibited a collection of economic insects at the Los Angeles Citrus Fair in September.	
	J. J. Rivers appointed curator of the Museum at University of California.	
	Matthew Cooke. A treatise on the insects injurious to fruit and fruit trees of the State of California. Sacramento.	
	C. V. Riley and H. G. Hubbard invented Riley-Hubbard kerosene emulsion.	
	H. Edwards. New Genera and Species of Ægeriidæ. 1881–1882.	
	J. H. Comstock. Reports on insects in Report United States Department of Agriculture, 1880 (1881).	
	A. S. Packard. Insects injurious to forest and shade trees. Revised, 1890.	
	Polycaon confertus *Lec. reported as a pest of olives at Vacaville, California.*	
	Indian meal moth, Plodia interpunctella *(Hbn.), recorded as a serious pest of dried fruits, in California.*	
	Greedy scale, Aspidiotus camelliæ *Sign., known as the Santa Cruz apple and pear scale, common in the central coast counties, California.*	
	Pacific peach tree borer described by Henry Edwards. Nevada.	

BIRTHS	EVENTS	DEATHS
	Brown apricot scale, Lecanium corni *Bouché, taken on pear at Cordelia, California.*	
	Grape phylloxera found in the counties of Sonoma, Napa, Solano, Yolo, Placer, and Eldorado by F. W. Morse.	
	California pear sawfly, Diphadnus californicus (*Marlatt*), *first noted at Sacramento.*	
	Cankerworms serious orchard pests, controlled by tin bands and arsenical sprays. California.	
	Mealy plum aphis, Hyalopterus arundinis (*Fabr.*), *reported on plums and prunes at Stockton and Los Angeles.*	
	Peach-twig borer, Anarsia lineatella *Zeller, a serious pest in California.*	
	Eggs of Bryobia prætiosa *Koch, on almond from San Diego, California, sent to H. Garman.*	
	Pacific mite, Tetranychus pacificus *McG., a serious pest in California.*	
	Clover leaf weevil, Hypera punctata (*Fabr.*), *first discovered in United States in Yates County, New York.*	
	Kerosene used as a summer spray for San José scale and proved to be very harmful to the trees.	
	Whale-oil soap used to control black scale on olive trees at Santa Barbara, California.	
	Pyrethrum used as remedy for grape leafhopper in California.	
	G. P. Rixford produced first crop of pistacio nuts in California at Sonoma.	
	First volume of Papilio appeared.	

Births	Events	Deaths
	L. Pasteur demonstrated anthrax vaccine. H. H. R. Koch discovered *Bacillus tuberculosis.* Southern Pacific Railroad completed. International Cotton Exposition, Atlanta, Georgia.	
	1882	
H. S. Barber (*U. S.*) *1882–* *C. W. Collins* (*U. S.*) *1882–* *W. P. Flint* (*U. S.*) *1882–* *C. W. Howard* (*U. S.*) *1882–* *E. R. deOng* (*U. S.*) *1882–* *R. S. Woglum* (*U. S.*) *1882–* *H. M. Russell* (*U. S.*) *1882–1915* *F. E. Miller* (*Can.*) *1882–*	First Report of Board of State Horticultural Commissioners of California. *Board of State Horticultural Commissioners appointed special committee to consider means of destroying and preventing the spread of the cottony cushion scale in the southern part of the state. California.* *Board of State Horticultural Commissioners gave warning against the introduction of the plum curculio into California.* *D. W. Coquillett first came to southern California.* *Felix Gillet first to record oak as the normal host of* Polycaon confertus *Lec. California.* *C. V. Riley confirmed the statement that the bean weevil continued to breed indefinitely in stored beans.* *White arsenic first used to control codling moth in Iowa by J. N. Dickson.* Ellwood Cooper. A treatise on olive culture. *S. A. Forbes appointed State Entomologist of Illinois.* *First course in entomology given at University of California by C. H. Dwinelle.* *Orchard mites common on fruit trees in California.*	*J. A. Putzeys* (*Belg.*) *1809–1882* Charles Darwin (Engl.) 1809–1882 F. M. Balfour (Engl.) 1851–1882 Henry W. Longfellow (U. S.) 1807–1882 Ralph Waldo Emerson (U. S.) 1803–1882

Births	Events	Deaths
	Pear root aphis, Eriosoma lanuginosa (*Hartig*), *first noted on pear roots in California.*	
	Squash bug, Anasa tristis (*DeGeer*), *common in the Sacramento Valley.*	
	Cankerworms serious pests in some orchards in California.	
	False chinch bug a pest in San Diego County, California.	
	Peach twig-borer a pest of apricots and peaches in California.	
	Italian pear scale recorded in the Santa Clara Valley, California.	
	Coccus olio *referred to as the scientific name of the black scale in California.*	
	Red-humped caterpillar, Schizura concinna (*A. & S.*), *taken on cherry in California.*	
	Tule beetle, Platynus maculicollis (*Dej.*), *reported as the "obnoxious overflow bug" or "grease bug" in California.*	
	The green bug, Toxoptera graminum *Rondani, was first noted in North America.*	
	S. H. Scudder. Nomenclator Zoölogicus.	
	Mary Treat. Injurious insects of the farm and garden. New York.	
	Sir John Lubbock. Ants, bees and wasps.	
	H. H. R. Koch established the etiology of tuberculosis.	
	F. Löffler and F. Schulze discovered the bacterium causing glanders.	
	T. A. Garey. Orange culture in California.	
	Chinese Exclusion Act.	

1883

Births

O. C. Bartlett (*U. S.*) *1883–*

H. E. Ewing (*U. S.*) *1883–*

H. J. Franklin (*U. S.*) *1883–*

D. B. Mackie (*U. S.*) *1883–*

H. L. Sanford (*U. S.*) *1883–*

E. R. Sasscer (*U. S.*) *1883–*

H. H. P. Severin (*U. S.*) *1883–*

H. S. Smith (*U. S.*) *1883–*

M. H. Swenk (*U. S.*) *1883–*

W. A. Thomas (*U. S.*) *1883–*

P. H. Timberlake (*U. S.*) *1883–*

R. A. Vickery (*U. S.*) *1883–*

H. B. Weiss (*U. S.*) *1883–*

H. F. Wilson (*U. S.*) *1883–*

M. A. Yothers (*U. S.*) *1883–*

Events

Act of March 13, created and established State Board of Horticulture and State Inspector of Fruit. California.

Fruit growers at California State convention demanded the introduction into the public schools of the study of economic entomology.

Bill in California legislature, to control and exterminate foul brood, failed.

F. C. Roeding established Fancher Creek Nursery at Fresno.

John Rock introduced into California 35 varieties of figs from England and 22 varieties from France for propagation at San José.

A. F. A. King published an extended argument to prove that malaria was carried by mosquitoes.

San José scale found in twenty counties of California.

Cottony cushion scale a severe pest in the citrus orchards of southern California.

Green apple aphis, Aphis pomi *DeGeer, troublesome in California.*

DeLong's caterpillar, Malacosoma constricta (*Stretch*), *a pest of apples in Marin County.*

J. L. LeConte and G. H. Horn erected the coleopterous suborder Adephaga.

Apanteles glomeratus (*Linn.*), *introduced into the United States by C. V. Riley and Otto Lugger, Div. Entom., U. S. D. A., and G. C. Bagnell of Plymouth, England.*

Deaths

J. L. LeConte (*U. S.*) *1825–1883*

V. T. Chambers (*U. S.*) *1830–1883*

Townsend Glover (*U. S.*) *1813–1883*

P. C. Zeller (*Germ.*) *1808–1883*

O. Heer (*Switz.*) *1809–1883*

F. W. Mäklin (*Finl.*) *1821–1883*

Births	Events	Deaths
	First specimens of cabbage butterfly, Pieris rapæ *(Linn.), taken in southern California in San Bernardino County by W. G. Wright. May.*	
	Matthew Cooke reported the presence of the cherry fruit sawfly, Hoplocampa cookei *(Clarke), in Solano County, California.*	
	Cankerworms serious pests in orchards in California.	
	Matthew Cooke. Injurious insects of the orchard, vineyard, etc. Sacramento.	
	1884	
E. R. Barber (U. S.) 1884–	*F. W. Morse determined the chief points in the life history of the grape phylloxera—few leaf galls found.*	*Gregory Sanborn (U. S.) 1838–1884*
F. C. Bishopp (U. S.) 1884–	*J. A. Bauer announced his discovery that finely divided mercury in the soil would control the grape phylloxera.*	*A. Förster (Foerster) (Germ.) 1810–1884*
J. C. Bradley (U. S.) 1884–	*James Fletcher appointed first honorary entomologist by the Department of Agriculture of Canada.*	*L. A. A. Chevrolat (Fr.) 1799–1884*
A. F. Braun (U. S.) 1884–	*F. M. Webster first noted the green bug on wheat in Indiana. July.*	*Johann (Gregor) Mendel (Aust.) 1822–1884*
F. L. Guyton (U. S.) 1884–	*Entomological Society of Washington organized by C. V. Riley.*	*J. G. Schiödte (Denm.) 1815–1884*
R. W. Harned (U. S.) 1884–	*Wash made of caustic soda, grease, and tobacco used for the control of black scale in California.*	
L. Haseman (U. S.) 1884–	*Road dust used for the control of the pear or cherry slug in the United States.*	
I. M. Hawley (U. S.) 1884–	*Whale-oil soap and iron compound recommended as the most effective insecticide for the San José scale in California.*	
J. A. Hyslop (U. S.) 1884–		
P. Luginbill (U. S.) 1884–		
E. McDaniel (U. S.) 1884–		
Alice Noyes (U. S.) 1884–		
J. R. Parker (U. S.) 1884–		

Births	Events	Deaths
H. F. Willard (*U. S.*) *1884–*	*Single specimen of the chinch bug,* Blissus leucopterus (*Say*), *collected near Alameda, California.*	
H. M. Parshley (*U. S.*) *1884–*	*Peach twig borer serious pest in California.*	
	European elm scale, Gossyparia spuria (*Modeer*), *first reported in the United States at Rye, New York.*	
	Bumblebees introduced into New Zealand and Australia, from North America, to pollenate red clover.	
	The California Cultivator began in Los Angeles.	
	The Pacific Tree and Vine started in San José.	
	West American Scientist published by C. R. Orcutt, San Diego.	
	Sir John Lubbock. Ants, bees and wasps. (First edition in 1882.)	
	A. Nicolaier discovered and described the tetanus bacillus.	
	Guavas distributed by the College of Agriculture, University of California.	
	Coffee plants sent to southern California for trial by the University of California.	
	Geo. Eastman patented the first successful roll film of paper. United States.	
	L. E. Waterman invented first successful fountain pen. United States.	

1885

Births	Events	Deaths
W. J. Bærg (*U. S.*) *1885–*	*Act of March 10 to prevent the spread and to extirpate fruit tree pests in California.*	*T. R. Peale* (*U. S.*) *1800–1885*

Births

A. C. Baker (*U. S.*) *1885–*

S. W. Bilsing (*U. S.*) *1885–*

J. J. Davis (*U. S.*) *1885–*

W.T. M. Forbes (*U. S.*) *1885–*

H. Glasgow (*U. S.*) *1885–*

H. B. Hungerford (*U. S.*) *1885–*

T. H. Jones (*U. S.*) *1885–*

G. M. List (*U. S.*) *1885–*

Z. P. Metcalf (*U. S.*) *1885–*

D. C. Parman (*U. S.*) *1885–*

O. E. Plath (*U. S.*) *1885–*

P. Rau (*U. S.*) *1885–*

W. S. Regan (*U. S.*) *1885–*

H. C. Severin (*U. S.*) *1885–*

T. E. Snyder (*U. S.*) *1885–*

A. T. Speare (*U. S.*) *1885–*

Events

Ellwood Cooper elected first president of the California State Board of Horticulture.

D. W. Coquillett appointed field agent, Division of Entomology, United States Department of Agriculture, by C. V. Riley, stationed in southern California.

D. W. Coquillett made known method of poisoning grasshoppers with poison bait.

A. Kœbele transferred to California by C. V. Riley and stationed at Alameda.

Lye and potash used as winter or dormant spray for San José scale in California.

A. Kœbele collected chinch bugs in numbers at Alameda, California.

E. J. Wickson first to report the Hessian fly, Phytophaga destructor (*Say*), *at Berkeley, California.*

C. Emery erected the coleopterous suborder Phytophaga.

F. Brauer erected the subclasses Apterygogenea and Pterygogenea for insects.

Brachyrhinus sulcatus (*Fabr.*), *found to be injurious to bulbs and house plants in Massachusetts by J. A. Lintner.*

G. Targioni-Tozzetti described the West Indian peach scale as Diaspis pentagona (Aulacaspis).

Clover mite in the United States described as Bryobia pratensis *by H. Garman.*

Fourth Report of the United States Entomological Commission.

Deaths

H. K. Morrison (*U. S.*) *1854–1885*

Births	Events	Deaths
R. L. Webster (*U. S.*) *1885–* *A. L. Lovett* (*U. S.*) *1885–1924* *H. O. Marsh* (*U. S.*) *1885–1918*	*Entomologica Americana replaced the Bulletin of the Brooklyn Entomological Society.* *H. G. Hubbard. Insects affecting the orange.* *T. L. Casey first collected Coleoptera in California.* 3,617,973 peach trees in California. Luther Burbank introduced the Satsuma plum into California from Japan. Hatch seedling almonds introduced into California. Sante Fe Railroad completed. World's Industrial Exposition at New Orleans. First linotype machine invented by O. Mergenthaler, Baltimore. King James' version of the Old Testament published.	
	1886	
G. G. Ainslie (*U. S.*) *1886–* *A. I. Bourne* (*U. S.*) *1886–* *D. J. Caffrey* (*U. S.*) *1886–* *E. N. Cory* (*U. S.*) *1886–* *J. E. Dudley, Jr.* (*U. S.*) *1886–* *T. E. Halloway* (*U. S.*) *1886–* *C. R. Kellogg* (*U. S.*) *1886–* *W. M. Mann* (*U. S.*) *1886–* *G. B. Merrill* (*U. S.*) *1886–*	First County Board of Horticultural Commissioners organized in California. *D. W. Coquillett, J. W. Wolfskill, and Alex. Craw began experimenting with HCN to kill scale insects on citrus trees.* *Resin wash advocated by A. Kœbele for control of the cottony cushion scale in California.* *Whale-oil soap commonly used as an insecticide.* *Hen flea or sticktight flea,* Echidnophaga gallinacea (*Westw.*), *first reported on hens in North America in Florida by L. C. Johnson.* *First specimens of the chrysanthemum leaf miner,* Diarthronomyia hypogæa (*F. Löw*),	*E. von Harold* (*Germ.*) *1830–1886*

Births	Events	Deaths
L. M. Peairs (*U. S.*) *1886–* *C. E. Pemberton* (*U. S.*) *1886–* *A. H. Rosenfeld* (*U. S.*) *1886–* *E. W. Scott* (*U. S.*) *1886–* *J. Zetek* (*U. S.*) *1886–*	*taken in United States, sent to Coquillett by Chas. Anderson, New York.* *Larch case-bearer,* Coleophora laricella *Hbn., discovered in America.* *C. V. Riley donated his collection of 115,000 specimens to the United States National Museum as the nucleus of an insect collection.* *S. H. Scudder began the study of North American insect paleontology.* *P. R. Uhler. Check list of the Hemiptera-Heteroptera of North America.* *S. W. Williston. On the classification of North American Diptera.* *L. C. Miall and A. Denny. The structure and life-history of the cockroach.* *Pruning off infested twigs and the applications of gas lime to the soil, recommended for the control of the peach twig borer.* Bartholdi's Statue of Liberty in New York Harbor unveiled.	

1887

J. W. Bulger (*U. S.*) *1887–* *S. S. Crossman* (*U. S.*) *1887–* *R. W. Dawson* (*U. S.*) *1887–* *E. H. Dusham* (*U. S.*) *1887–* *A. A. Granovsky* (*Russ.*) *1887–*	Hatch Act provided for the establishment and maintenance of agricultural experiment stations in all land-grant colleges. Association of American Agricultural Colleges and Experiment Stations organized. *C. V. Riley addressed the Seventh California State Fruit Growers' convention at Riverside, April 11.*	*Matthew Cooke* (*U. S.*) *1829–1887* *H. Feldman* (*U. S.*) *1814–1887* *Max Gemminger* (*Germ.*) *1822–1887*

Births	Events	Deaths
V. R. Haber (*U. S.*) *1887–* *M. Hebard* (*U. S.*) *1887–* *D. Isley* (*U. S.*) *1887–* *E. W. Laake* (*U. S.*) *1887–* *Wm. Moore* (*U. S.*) *1887–* *D. C. Mote* (*U. S.*) *1887–* *R. A. Muttkowski* (*U. S.*) *1887–* *T. H. Parks* (*U. S.*) *1887–* *W. A. Price* (*U. S.*) *1887–* *C. H. Richardson* (*U. S.*) *1887–* *E. A. Richmond* (*U. S.*) *1887–* *S. A. Rohwer* (*U. S.*) *1887–* *M. T. Smulyan* (*U. S.*) *1887–* *F. L. Thomas* (*U. S.*) *1887–* *W. R. Thompson* (*U. S.*) *1887–* *C. A. Weigel* (*U. S.*) *1887–* *B. P. Young* (*U. S.*) *1887–* *L. S. McLaine* (*Engl.*) *1887–*	Alfred Russel Wallace visited California on a lecturing and sightseeing tour. *Alex. Craw suggested natural enemies for the control of the cottony cushion scale and advocated sending Coquillett to Australia for that purpose.* *F. W. Morse published results on the use of gases to control scale insects on citrus trees.* *D. W. Coquillett published report on gas treatment for scale insects.* *Paris green and banding recommended by E. J. Wickson for the control of codling moth in California.* *Brown apricot scale taken in Los Angeles by D. W. Coquillett and A. Craw.* *Horn fly,* Hæmatobia serrata *Desv., noted in New Jersey.* *Mediterranean flour moth,* Ephestia kuehniella *Zeller, first noted in North America in Canada.* *Mottled willow borer,* Cryptorhynchus lapathi (*Linn.*), *discovered in North America.* *E. T. Cresson. Synopses of the families and genera of the Hymenoptera, north of Mexico, etc.* *W. M. Maskell. An account of New Zealand scale insects.* D. Bruce discovered the bacterial organism in the spleen causing Malta fever. Interstate Commerce Commission created.	

Births	Events	Deaths
	1888	
Leroy Childs (*U. S.*) *1888–*	*A. Kœbele sailed for Australia to collect parasites for the cottony cushion scale in California.*	Asa Gray (U. S.) 1810–1888
R. J. Fiske (*U. S.*) *1888–*	*D. W. Coquillett improved HCN fumigation by pot generation.*	*G. R. Waterhouse* (*Engl.*) *1810–1888*
P. M. Gilmer (*U. S.*) *1888–*	*Dipterous parasite*, Cryptochætum iceryæ (*Will.*), *of cottony cushion scale first introduced into California.*	
J. L. King (*U. S.*) *1888–*	*First lot of vedalia arrived from Australia in California. November 30.*	
W. V. King (*U. S.*) *1888–*	*Potash, caustic soda, and water recommended as the best remedy for the San José scale.*	
P. B. Lawson (*U. S.*) *1888–*	*White arsenic, London purple, and Paris green used to control codling moth.*	
F. L. McDonough (*U. S.*) *1888–*	*Lime-sulfur-salt wash first recommended for the control of the San José scale in California.*	
C. L. Metcalf (*U. S.*) *1888–*	*Potato tuber moth discovered in Los Angeles.*	
A. V. Mitchener (*U. S.*) *1888–*	*Strawberry crown moth*, Synanthedon bibionipennis (*Bdv.*), *first observed as a pest of strawberries in California.*	
R. H. Painter (*U. S.*) *1888–*	*C. V. Riley called attention to the Mexican orange maggot*, Anastrepha ludens (*Loew*), *in Mexico.*	
R. R. Parker (*U. S.*) *1888–*	*A. J. Cook first to use carbon disulfide as an insecticide in the United States.*	
Alva Peterson (*U. S.*) *1888–*	*Otto Lugger appointed State Entomologist of Minnesota.*	
V. I. Safro (*U. S.*) *1888–*	California Fruit Grower (Calif. Fruit News) established in San Francisco.	
E. H. Siegler (*U. S.*) *1888–*	S. C. Matteson invented the combined harvester and thresher. United States.	
R. H. Smith (*U. S.*) *1888–*		
R. C. Smith (*U. S.*) *1888–*		
G. J. Spencer (*India*) *1888–*		

Births	Events	Deaths
	Eastman and Walker invented the kodak, roll film hand camera. United States.	
	H. de Chardonnet patented process for making artificial silk. France.	
	Pasteur Institute in Paris opened.	
	J. H. Comstock. An introduction to entomology. Ithaca, N.Y.	
	Insect Life started by C. V. Riley.	
	J. Lubbock. On the senses, instincts and intelligence of animals. London.	
	S. W. Williston. Synopsis of the families and genera of North American Diptera.	
	Agricultural Building erected at the University of California.	
	1889	
A. J. Ackerman (U. S.) 1889–	J. G. Pressley, Judge of the Superior Court of Sonoma County, rendered a decision to the effect that the appointment of County Boards of Horticultural Commissioners was mandatory upon Boards of Supervisors.	*S. F. Chapin (U. S.) 1839–1889*
C. P. Alexander (U. S.) 1889–	County Boards of Horticultural Commissioners appointed in 19 counties in California.	*V. A. Signoret (Fr.) 1816–1889*
W. V. Balduf (U. S.) 1889–	*J. B. Smith appointed entomologist in the New Jersey Agricultural Experiment Station.*	*J. B. L. Buquet (Fr.) 1807–1889*
G. G. Becker (U. S.) 1889–	*H. Garman began entomological work in Kentucky.*	*E. Desmarest (Fr.) 1816–1889*
T. R. Chamberlin (U. S.) 1889–	*Resin wash for scale insects perfected in California by Coquillett.*	*P. H. Lucas (Fr.) 1814–1889*
R. N. Chapman (U. S.) 1889–	*E. P. Fowler secured patent for a process of destroying scale insects with a sand blast in California.*	*F. Löw (Aust.) 1829–1889*
C. R. Cleveland (U. S.) 1889–	*Lime-sulfur-salt spray modified.*	
D. L. Crawford (U. S.) 1889–		
C. W. Creel (U. S.) 1889–		

Births

J. C. Evendon (*U. S.*) *1889–*

S. B. Fracker (*U. S.*) *1889–*

B. B. Fulton (*U. S.*) *1889–*

J. E. Graf (*U. S.*) *1889–*

C. H. Hadley, Jr. (*U. S.*) *1889–*

J. D. Hood (*U. S.*) *1889–*

W. H. Larrimer (*U. S.*) *1889–*

J. W. McColloch (*U. S.*) *1889–*

J. A. Manter (*U. S.*) *1889–*

P. W. Mason (*U. S.*) *1889–*

C. M. Packard (*U. S.*) *1889–*

O. W. Park (*U. S.*) *1889–*

O. W. Rosewall (*U. S.*) *1889–*

A. Spuler (*U. S.*) *1889–*

G. N. Wolcott (*U. S.*) *1889–*

W. H. Brittain (*Can.*) *1889-*

Events

Purple scale, Lepidosaphes becki (*Newm.*), *introduced into California from Florida.*

American dried apples prohibited in Hamburg, Germany, because of presence of zinc oxide.

California tortoise shell butterfly, Aglais california (*Bdv.*), *reported swarming above snow line on Mt. Shasta by C. L. Hopkins.*

Chaff scale, Parlatoria pergandei *Comst., first noted in California at Pomona.*

Purple scale noted at Pomona, California.

First Colorado potato beetle taken as far south as Mississippi.

Corn earworm, Heliothis obsoleta (*Fabr.*), *noted in California by D. W. Coquillett.*

Mexican bean beetle, Epilachna corrupta *Muls., reported injurious to beans in New Mexico.*

A. C. F. Morgan described the dictyospermum scale as Aspidiotus dictyospermi (Chrysomphalus), *from specimens collected in Demerara, British Guiana.*

Gypsy moth noted as a pest in Massachusetts.

Association of Official Economic Entomologists organized in November at Washington, D. C., by C. V. Riley.

Cuttings of Kadota (Dottato) fig introduced into Riverside, California, by U. S. Department of Agriculture and Twogood and Cutter.

World association of museums founded.

S. H. Scudder. Butterflies of eastern United States and Canada.

Deaths

Births	Events	Deaths
	F. Galton. Natural inheritance. London.	
	A. R. Wallace. Darwinism. London.	
	Jamestown Flood.	
	1890	
G. W. Barber (*U. S.*) *1890–*	*Quarantine inspection work organized in California.*	*S. A. de Marseul* (*Fr.*) *1812–1890*
R. E. Campbell (*U. S.*) *1890–*	Second Morrill Act—appropriating to land-grant colleges national funds arising from sale of public lands.	*Louis Reiche* (*Hol.*) *1799–1890*
H. G. Dietz (*U. S.*) *1890–*		*E. T. Atkinson* (*India*) *1840–1890*
C. C. Hill (*U. S.*) *1890–*	*Geo. Roeding artificially caprified Smyrna figs at Fresno.*	
L. O. Jackson (*U. S.*) *1890–*	*Blastophaga first introduced into California by G. A. Eisen, J. Shinn, and J. Bliss.*	
D. W. Jones (*U. S.*) *1890–*	*Lime-sulfur-salt spray used in Sutter County, California.*	
F. P. Keen (*U. S.*) *1890–*	*Date palms from Algiers and Egypt, infested with date palm scales, received by United States Department of Agriculture, treated with kerosene emulsion, and shipped to Arizona and California.*	
M. D. Leonard (*U. S.*) *1890–*		
U. C. Loftin (*U. S.*) *1890–*		
S. Marcovitch (*U. S.*) *1890–*	*Hop aphis*, Phorodon humuli (*Schrank*), *first noted in Oregon and Washington.*	
T. B. Mitchell (*U. S.*) *1890–*		
Harold Morrison (*U. S.*) *1890–*	*Mediterranean fruit fly*, Ceratitis capitata *Wied.*, *first noted in Bermuda.*	
E. J. Newcomer (*U. S.*) *1890–*	*Buffalo carpet beetle*, Anthrenus scrophulariæ (*Linn.*), *first noted in American insect collections.*	
L. B. Smith (*U. S.*) *1890–*	*Leopard moth*, Zeuzera pyrina (*Linn.*), *first noted in Brooklyn, New York, by Nicolas Rike.*	
E. J. Vosler (*U. S.*) *1890–1918*	*Brown-tail moth introduced into Massachusetts between 1890 and 1893.*	
W. H. Wellhouse (*U. S.*) *1890–*	*Fifth Report United States Entomological Commission.*	

Births	Events	Deaths
	S. Henshaw began Bibliography of American Economic Entomology.	
	Entomological News started in Philadelphia.	
	Proceedings of the Entomological Society of Washington first issued.	
	T. Lowne. The anatomy, physiology, morphology, and development of the blow fly. 2 vols. London, 1890–1895.	
	Gustav A. Eisen. The raisin industry, etc.	
	R. Hertwig. Lehrbuch der zoölogie. Jena.	
	International Phytopathological Commission founded in Europe.	
	The Yosemite National Park created by act of Congress.	
	1891	
C. H. Batchelder (U. S.) 1891–	*California State Legislature appropriated $5,000 to send an expert to foreign countries to collect beneficial insects.*	*Edw. Burgess (U. S.) 1848–1891*
C. S. Beckwith (U. S.) 1891–	*Alex. Craw appointed Quarantine officer and ex-officio entomologist of the California State Board of Horticulture.*	*Joseph Leidy (U. S.) 1823–1891*
C. L. Fluke (U. S.) 1891–	*A. Kœbele made second trip to Australia to collect parasites for introduction into California.*	*Henry Edwards (U. S.) 1830–1891*
S. B. Freeborn (U. S.) 1891–	*C. W. Woodworth began teaching entomology at the University of California.*	*S. S. Rathvon (U. S.) 1812–1891*
S. W. Frost (U. S.) 1891–	*Alex. Craw reported the fall cankerworm,* Alsophila pometaria *(Harris), in California.*	
P. Garman (U. S.) 1891–	*Brown apricot scale again recorded in California.*	
E. H. Gibson (U. S.) 1891–	*Grasshopper plague controlled by poison baits in California.*	
A. Hartzell (U. S.) 1891–		
F. H. Lathrop (U. S.) 1891–		

Births	Events	Deaths
A. C. Mason (*U. S.*) *1891–* *H. K. Plank* (*U. S.*) *1891–* *F. W. Poos* (*U. S.*) *1891–* *E. E. Russell* (*U. S.*) *1891–* *H. L. Seamans* (*U. S.*) *1891–* *H. G. Crawford* (*Can.*) *1891–* *E. M. DuPorte* (*Can.*) *1891–*	*Western cricket,* Anabrus simplex *Hald., invaded Siskiyou County, California.* *Specimens of potato tuber moth from California first received by Division of Entomology, United States Department of Agriculture.* *Green clover hopper,* Stictocephala inermis (*Fabr.*), *injurious to young peach trees in Tehama Co., California.* *Argentine ant,* Iridomyrmex humilis (*Mayr*), *first noted in New Orleans by E. Foster.* *Black vine weevil,* Brachyrhinus sulcatus (*Fabr.*), *noted as a hothouse pest in England.* *C. V. Riley and F. Enoch introduced the chalcid parasite,* Entedon epigonus *Walk., of the Hessian fly, into the United States from England.* *A. D. MacGillivray began publishing on the Thysanura of North America.* C. P. Taft planted the first commercial orchard of loquats near Orange, California. Experimental shipment of fresh fruits from California to London, England. Canadian Pacific Railroad completed. Farmers' Institute work began by College of Agriculture, University of California.	

1892

Births	Events	Deaths
H. W. Allen (*U. S.*) *1892–* *F. R. Cole* (*U. S.*) *1892–* *D. M. Delong* (*U. S.*) *1892–*	*The mealybug destroyer,* Cryptolæmus montrousieri *Muls., introduced into California.* *Olive scale,* Pollinia pollini (*Costa*), *taken on a few olive trees near Los Angeles.*	*J. W. Randall* (*U. S.*) *1813–1892* *Leon Provancher* (*Can.*) *1820–1892*

Births	Events	Deaths
E. W. Dunnam (*U. S.*) *1892–*	*Mexican cotton boll weevil,* Anthonomus grandis *Boh., introduced into Texas.*	*H. T. Stainton* (*Engl.*) *1822–1892*
A. G. Dustan (*U. S.*) *1892–*	*A. D. Hopkins imported more than a thousand adults of* Thanasinus formicarius *Linn., a clerid beetle, to prey upon bark-beetles in West Virginia.*	Richard Owen (Engl.) 1804–1892
F. A. Fenton (*U. S.*) *1892–*	*West Indian peach scale,* Aulacaspis pentagona (Targ.), *first noted in the United States.*	H. W. Bates (Engl.) 1825–1892
R. W. Leiby (*U. S.*) *1892–*	*Poisoned clover and fresh herbage used to control cutworms in California.*	*H. C. Burmeister* (*Argent.*) *1807–1892*
B. A. Porter (*U. S.*) *1892–*	*B. M. Lelong. The blastophaga. ——The horticultural history of California.*	*C. A. Dohrn* (*Germ.*) *1806–1892*
P. Simmons (*U. S.*) *1892–*	*J. H. Comstock gave a course of lectures on entomology at Stanford University and at the San José State Normal School.*	
L. A. Stearns (*U. S.*) *1892–*	*J. H. Comstock erected the lepidopterous suborder Jugatæ.*	
F. S. Stickney (*U. S.*) *1892–*	*New York Entomological Society organized.*	
G. H. Vansell (*U. S.*) *1892–*	*T. Smith and F. L. Kilborne discovered the rôle of the cattle tick,* Margaropus annulatus *Say, in the transmission of the protozoan,* Babesia bigemina *S. & K., causing Texas fever of cattle.*	
F. M. Wadley (*U. S.*) *1892–*	*C. W. Tutt. British Noctuæ and their varieties. Vol. II. London.*	
W. H. White (*U. S.*) *1892–*	A. Weismann. *Das keimplasma.* Jena.	
F. H. Wymore (*U. S.*) *1892–*	P. Pfeiffer, P. Canon, and S. Kitasato independently announced the discovery of the influenza bacillus.	
	Chas. E. Duryea built first automobile in America.	
	F. E. Ives invented color photography. United States.	

Births	Events	Deaths
	1893	
G. H. Bradley (*U. S.*) *1893–*	*V. L. Kellogg became assistant professor of entomology at Stanford University.*	*H. A. Hagen* (*U. S.*) *1817–1893*
L. L. Buchanan (*U. S.*) *1893–*	*E. M. Ehrhorn reported European elm scale,* Gossyparia spuria (*Mod.*), *at Palo Alto.*	*I. C. Martindale* (*U. S.*) *1842–1893*
C. P. Clausen (*U. S.*) *1893–*	*Dusting machine first used to apply sulfur to control mildew of grapes and orchard mites in California.*	*J. O. Westwood* (*Engl.*) *1805–1893*
K. L. Cockerham (*U. S.*) *1893–*		John Tyndall (Engl.) 1820–1893
L. V. Coleman (*U. S.*) *1893–*	*The grapevine hoplia,* Hoplia callipyge *Lec., first observed injuring grapevines at Selma and Fresno, California.*	*Giov. Passerini* (*It.*) *1816–1893*
C. R. Cutright (*U. S.*) *1893–*		
	The western blood-sucking cone nose, Triatoma protracta (*Uhler*), *reported biting humans in the Yosemite Valley.*	
G. F. Ferris (*U. S.*) *1893–*	*Manzanita serica,* Serica anthracina *Lec., reported injurious to foliage of plum trees at Riverdale, California.*	
M. Hertig (*U. S.*) *1893–*		
W. S. Hough (*U. S.*) *1893–*	*Reaper dart,* Euxoa messoria (*Harris*), *and the variegated cutworm,* Lycophotia margaritosa (*Haw.*), *injurious to young shoots of grapevines in the spring in Fresno County, California.*	
L. L. Huber (*U. S.*) *1893–*		
M. C. Lane (*U. S.*) *1893–*		
C. R. Neiswander (*U. S.*) *1893–*	*Cypress twig-borer,* Phlœosinus cristatus (*Lec.*), *observed injuring Monterey cypress hedges in Contra Costa County, California.*	
H. L. Parker (*U. S.*) *1893–*		
L. H. Taylor (*U. S.*) *1893–*	*D. W. Coquillett first to rear the zebra caterpillar,* Ceramica picta (*Harris*), *in California.*	
W. C. Woods (*U. S.*) *1893–*		
E. Hearle (*India*) *1893–*	*D. W. Coquillett transferred from California to Washington, D. C.*	
R. T. Cotton (*Engl.*) *1893–*	*Bordeaux mixture first combined with Paris green to control scab and codling moth.*	

Births	Events	Deaths
	Insect pest survey first inaugurated by the Division of Entomology, United States Department of Agriculture.	
	San José scale first discovered in the East in Virginia.	
	S. A. Forbes organized the International Congress of Zoölogists at the Columbian Exposition, Chicago.	
	A. Kœbele employed to collect parasites for the territory of Hawaii.	
	Journal New York Entomological Society started.	
	W. H. Ashmead. Monograph North American Proctotrypidæ.	
	L. O. Howard published results of the use of kerosene for the control of mosquitoes.	
	World Columbian Exposition at Chicago.	

1894

Births	Events	Deaths
W. B. Cartwright (U. S.) 1894–	*Alex. Craw first reported pear leaf blister mite,* Eriophyes pyri *(Pagen.), in California.*	*Edw. Norton (U. S.) 1823–1894*
E. A. Chapin (U. S.) 1894–	*Paris green and rye bran used by R. C. Allen to control cutworms in southern California.*	*L. J. Xanthus de Vesey (Hung.) 1825–1894*
J. D. Douglass (U. S.) 1894–	*Bean thrips described by Pergande as* Heliothrips fasciatus *from a specimen taken on an orange tree in Yuba County, California, by G. W. Harney.*	
C. O. Eddy (U. S.) 1894–	*Outbreak of California oak moth,* Phryganidia californica *Pack., in the Santa Clara Valley. In the fall and also in the spring of 1895.*	
A. G. Kinsey (U. S.) 1894–	*Mexican cotton boll weevil first discovered in the United States in Texas.*	
C. F. W. Muesebeck (U. S.) 1894–		
R. A. St. George (U. S.) 1894–		

Births	Events	Deaths
R. C. Shannon (U. S.) 1894– *M. R. Smith (U. S.) 1894–* *H. Spencer (U. S.) 1894–*	*Cabbage seed stalk weevil,* Ceutorhynchus quadridens (*Panzer*), *first reported in America from Long Island, New York, by M. V. Slingerland.* *G. Del Guercio named the Italian pear scale,* Aspidiotus piricola (Diaspis). *L. O. Howard appointed Chief, Division of Entomology, United States Department of Agriculture.* *J. B. Smith appointed State Entomologist of New Jersey.* *M. V. Slingerland published the first spray calendar.* S. Kitasato and A. E. J. Yersin independently discovered the plague bacillus. John Rock received from the United States Department of Agriculture scions of 65 varieties of figs for propagation at San José. E. Dubois described *Pithecanthropus erectus* from Java. C. Francis Jenkins produced first moving pictures by modern methods. United States. Hawaii recognized as a republic.	
	1895	
F. H. Benjamin (U. S.) 1895– *W. C. Cook (U. S.) 1895–* *T. H. Frison (U. S.) 1895–* *H. L. Dozier (U. S.) 1895–* *J. I. Hambleton (U. S.) 1895–*	*Use of Paris green at its height throughout the United States.* *C. F. Baker described the beet leafhopper as* Thamnotettix tenella (Eutettix). *The golden mealybug,* Pseudococcus aurilanatus (*Mask.*), *noted in California on araucaria trees imported from Australia.* *L. O. Howard appointed Honorary Curator of Insects, United States National Museum.*	*C. V. Riley (U. S.) 1843–1895* *Geo. Marx (U. S.) 1838–1895* *L. L. Langstroth (U. S.) 1810–1895* *O. Radoshkowsky (Russ.) 1820–1895* L. Pasteur (Fr.) 1822–1895

Births	Events	Deaths
O. C. McBride (*U. S.*) *1895–*	*L. O. Howard. Revision of the Aphelininæ of North America.*	T. H. Huxley (Engl.) 1825–1895
O. I. Snapp (*U. S.*) *1895–*	*J. H. and A. B. Comstock. Manual for the study of insects. Ithaca, N. Y.*	
H. N. Worthley (*U. S.*) *1895–*	*J. H. Comstock erected the order Mecpotera.*	
	A. S. Packard. Monograph of the Bombycine Moths, 1895–1914.	
	J. L. Hancock. The Tetrigidæ of North America.	
	Zoölogischer Centralblatt started at Leipzig.	
	D. Bruce showed that nagana of domestic animals was caused by a trypanosome reinjected by the tsetse fly.	
	Marconi invented radiotelegraph. Italy.	
	X-rays discovered by Wm. K. Roentgen. Germany.	

1896

E. L. Chambers (*U. S.*) *1896–*	*D. W. Coquillett appointed honorary custodian of Diptera at the U. S. National Museum.*	*E. G. Lodeman* (*U. S.*) *1867–1896*
J. C. Hamlin (*U. S.*) *1896–*	*E. G. Lodeman. The spraying of plants. New York.*	*P. F. Morawitz* (*Russ.*) *1827–1896*
W. E. Hoffman (*U. S.*) *1896–*	*S. W. Williston. Manual of the families and genera of North American Diptera.*	
K. M. King (*U. S.*) *1896–*	*H. Osborn. Insects affecting domestic animals.*	
	A. Weismann. Über germinalselektion. Jena.	
	Concilium Bibliographicum started at Geneva.	
	E. van Ermengem discovered the anaërobic bacillus causing botulism.	
	Geo. Carmack struck gold on Bonanza Creek, in the Klondike-Yukon region. August 16.	

BIRTHS	EVENTS	DEATHS
	1897	
J. L. Buys (U. S.) 1897– *T. H. Hubbell (U. S.) 1897–* *W. D. Reed (U. S.) 1897–* *G. C. Wheeler (U. S.) 1897–* *W. Carter (Engl.) 1897–*	*First National Quarantine bill drafted in Washington following the introduction of the San José scale into the Eastern states. Failed in Congress.* *Brown-tail moth first observed as injurious in Massachusetts.* *D. W. Coquillett. Revision of Tachinidæ of America north of Mexico.* *J. H. Comstock. Insect Life.* *S. H. Scudder. Guide to the genera and classification of the North American Orthoptera found north of Mexico. Revision of the Orthoptera group Melanopli, etc.* Beginning of instruction in University extension work in agriculture, University of California.	*John Hamilton (U. S.) 1827–1897* *G. H. Horn (U. S.) 1840–1897* *M. L. Linell (Sw.) 1849–1897* E. D. Cope (U. S.) 1840–1897 *P. Montrousier (Fr.) 1821–1897*
	1898	
E. H. Bryan, Jr. (U. S.) 1898– *J. C. Chamberlin (U. S.) 1898–* *F. L. Campbell (U. S.) 1898–* *M. H. Hatch (U. S.) 1898–*	*Sugar cane leafhopper,* Perkinsiella saccharicida *Kirk., introduced into Hawaii from Australia about this time.* *Geo. Compere first called attention to the presence of the melon fly,* Bactrocera cucurbitæ *(Coq.), in Honolulu. November.* *W. J. Holland became director of the Carnegie Museum.* *E. P. Felt became State Entomologist of New York.* *H. Osborn began teaching entomology at Ohio State University.* *New York State first enacted a law to regulate the sale of Paris green.* *A. S. Packard. Text book of entomology.*	*J. A. Lintner (U. S.) 1822–1898* *James Behrens (U. S.) 1824–1898* *W. M. Maskell (N. Z.) 1840–1898* *E. C. A. Candèze (Belg.) 1827–1898* *E. L. Taschenberg (Germ.) 1818–1898* *O. Salvin (Engl.) 1835–1898* W. E. Gladstone (Engl.) 1809–1898

Births	Events	Deaths
	G. W. Peckham. On instincts and habits of solitary wasps.	
	R. Ross discovered the rôle of the mosquito in the transmission of the malarial parasite.	
	T. J. Parker and W. A. Haswell. A textbook of Zoölogy. 2 vols. London.	
	K. Siga discovered the bacterium causing dysentery.	
	War with Spain—Treaty of Paris.	
	Annexation of Hawaii.	
	Yukon gold rush.	
	Radium discovered by Mme. Curie.	

1899

Births	Events	Deaths
W. E. Fleming (U. S.) 1899–	*California State Horticultural quarantine law passed, March 11.*	*H. G. Hubbard (U. S.) 1850–1899*
A. E. Miller (U. S.) 1899–	*Alex. Craw first took the Mexican orange maggot,* Anastrepha ludens *(Loew), in quarantine at San Francisco.*	*A. Costa (It.) 1828–1899*
	Wadsworth National Quarantine bill introduced into Congress—failed.	
	American Association of Economic Entomologists organized.	
	Golden spider beetle, Niptus hololeucus *Fald., first reported in North America at Halifax, Canada.*	
	Cabbage weevil, Ceutorhynchus cyanipennis *Germ., first noted in the United States at Ithaca, N. Y., by F. H. Chittenden.*	
	J. H. Comstock. The wings of insects. Ithaca.	
	H. F. Bassett. New North American Cynipidæ.	
	A. S. Packard. Entomology for Beginners.	

Births	Events	Deaths
	J. H. Comstock and V. L. Kellogg. The elements of insect anatomy.	
	R. Ross. Life history of the parasites of malaria.	
	D. Sharp. Fauna Hawaiiensis. Many pls. 1899–1908.	
	1900	
G. A. Fitch (*U. S.*) *1900–*	B. M. Lelong. Culture of the citrus in California.	*G. D. Hulst* (*U. S.*) *1846–1900*
C. C. Hamilton (*U. S.*) *1900–*	C. L. Morgan. Animal behavior. London.	*M. E. Selys-Longchamps* (*Belg.*) *1813–1900*
	California Cured Fruit Association organized at San José. January 15.	
	Benjamin Holt invented the caterpillar tractor. United States.	
	1901	
	First California State Insecticide law passed to prevent fraud in the sale of Paris green.	*F. H. Strecker* (*U. S.*) *1836–1901*
	Pacific Coast Entomological Society organized by Carl Fuchs, San Francisco, as the California Entomological Club.	*Otto Lugger* (*U. S.*) *1844–1901*
	Colorado potato beetle, Leptinotarsa 10-lineata (*Say*), *introduced into Great Britain.*	*B. M. Lelong* (*U. S.*) *1858–1901*
	Carrot rust fly, Psila rosæ (*Fabr.*), *discovered in the United States.*	*E. A. Ormerod* (*Engl.*) *1823–1901*
	H. C. Fall. List of the Coleoptera of southern California.	
	S. H. Scudder. Index to North American Orthoptera.	
	L. O. Howard. Mosquitoes. New York.	
	J. G. Needham. Aquatic insects in the Adirondacks.	
	Hugo de Vries, Die mutationstheorie. Leipzig.	

Births	Events	Deaths
	American Yellow Fever Commission demonstrated that yellow fever was transmitted by mosquitoes.	
	R. M. Forde and J. E. Dutton discovered the trypanosome causing sleeping sickness.	
	C. R. Orcutt discovered the animal deposits at the Rancho Le Brea, Los Angeles, California.	
	F. Franceschi introduced the feijoa into Santa Barbara, California.	
	1902	
H. S. Swingle (*U. S.*) *1902–*	Scutellista cyanea *Mots., introduced into California by L. O. Howard and C. P. Lounsbury.*	*H. F. Bassett* (*U. S.*) *1826–1902*
F. H. Wilson (*U. S.*) *1902–*	*C. L. Marlatt sent* Chilocorus similis *Rossi, a predator of the San José scale, from China to the United States.*	*J. G. Cooper* (*U. S.*) *1830–1902*
	Lantana insects introduced from Mexico into Hawaiian Islands by A. Kœbele.	R. L. C. Virchow (Germ.) 1821–1902
	Sugar cane leafhopper, Perkinsiella saccharicida *Kirk., first noted as injurious to sugar cane in Hawaii.*	
	F. H. Chittenden appointed in charge of truck crop insect investigations, Bureau of Entomology.	
	W. L. Distant. Rhynchota. 7 vols. 1902–1918.	
	D. E. Salmon and C. W. Stiles. Cattle ticks (Ixodoidea) of the United States.	
	H. G. Dyar. A list of North American Lepidoptera.	
	S. J. Hunter. Elementary studies in insect life.	

Births	Events	Deaths
	L. O. Howard. The insect book. New York.	
	W. G. Johnson. Fumigation methods. New York.	
	Washington Academy of Sciences organized.	
	P. Wytsman. Genera Insectorum. Fascicle I.	
	H. Graham discovered the relation of mosquitoes to dengue fever.	
	Blue pod bean discovered by P. Scolari at Lompoc, California.	
	First wireless message sent across the Atlantic.	
	1903	
	State Commissioner of Horticulture substituted for State Board of Horticultural Commissioners. California.	*C. A. Blake (U. S.) 1834–1903*
	Ellwood Cooper appointed first State Commissioner of Horticulture of California. (Served until 1907.)	*A. R. Grote (Germ.) 1841–1903*
	First California state bee law approved.	*Herbert Spencer (Engl.) 1820–1903*
	California fertilizer law passed.	*Karl Gegenbaur (Germ.) 1826–1903*
	Tree distillate—22° to 29° Baumé—used to control black scale on citrus trees in California.	
	C. F. Baker. Invertebrata Pacifica started, 1903–1907.	
	C. R. Osten Sacken. Record of my life work in entomology. Pts. I and II, pt. III, 1904.	
	M. E. Fernald. A catalogue of the Coccidæ of the world. Amherst, Mass.	
	J. G. Needham. A genealogic study of dragonfly wing venation. Ithaca, N. Y.	

Births	Events	Deaths
	N. J. Kusnezov erected the order Embiodea.	
	G. Enderlein erected the order Embiidina.	
	T. H. Morgan. Evolution and adaptation.	
	D. Bruce and D. Nabarro experimentally proved that the trypanosome believed to cause sleeping sickness was introduced into humans by the bite of the tsetse fly.	
	Belladonna plants first started in the garden of medicinal plants in the Golden Gate Park, San Francisco.	
	California poppy made the state flower by an act of the legislature.	
	Wright Brothers successfully operated an airplane. United States.	
	Pacific cable completed.	
	1904	
	Mosquito control campaign conducted by H. J. Quayle at Burlingame, California.	*Robt. M'Lachlan (Engl.) 1837–1904*
	Pear thrips, Tæniothrips inconsequens (*Uzel*), *first reported as a pest in the Santa Clara Valley, California.*	*H. H. Behr (U. S.) 1818–1904*
	Asparagus beetle, Crioceris asparagi (*Linn.*), *first reported in California.*	*F. G. Schaupp (U. S.) ?–1904*
	E. G. Titus published on the Argentine ant, Iridomyrmex humilis (*Mayr*), *in the United States.*	*F. M. Brauer (Germ.) 1831–1904*
	Powdered potassium cyanide recommended for the destruction of ants by H. A. Gossard in Florida.	

Births	Events	Deaths
	Alfalfa weevil, Hypera postica *(Gyll.), first discovered in United States in Utah.*	
	Alex. Craw organized the plant quarantine service in Hawaii.	
	Hawaiian Entomological Society organized.	
	Paranagrus optabilis *Perkins and* P. perforator *Perkins, egg parasites of the sugar cane leaf-hopper,* Perkinsiella saccharicida *Kirk., introduced into Hawaii from Queensland and Fiji by A. Kœbele and R. C. L. Perkins, 1904–1905.*	
	W. H. Ashmead. Classification of the super families of Hymenoptera.	
	J. B. Smith. Report on the mosquitoes of New Jersey.	
	E. P. Felt. The mosquitoes or Culicidæ of New York state.	
	W. H. Ashmead. Classification of the Chalcidoidea.	
	Theo. Pergande. North American Phylloxerinæ affecting Hicoria and other trees.	
	L. Henneguy. Les insectes. Paris.	
	A. Weismann. The evolution theory.	
	Chestnut bark disease first noted as a serious pest near New York City.	
	Louisiana Purchase Exposition at St. Louis.	

1905

Births	Events	Deaths
	Act relating to County Boards of Horticulture revised.	*A. S. Packard (U.S.) 1839–1905*
	California Quarantine Order No. 1, relating to citrus white fly, issued Oct. 3.	*G. W. Dunn (U. S.) 1814–1905*

Births	Events	Deaths
	California State Board of Health provided for the regulation of insects as health measures.	*H. Landois (Germ.) 1835–1905*
	Garden Centipede, Scutigerella immaculata *Newp., first recorded injurious to crops in California by C. W. Woodworth.*	*H. L. F. de Saussure (Switz.) 1829–1905*
	Mediterranean fig scale, Lepidosaphes ficus (*Sign.*), *introduced into California probably on fig cuttings. 1904 or 1905.*	*R. A. von Kölliker (Switz.) 1817–1905*
	E. D. Ball suspected the beet leafhopper, Eutettix tenellus (*Baker*), *as the carrier of curly leaf disease of sugar beets in the west.*	
	Grass mite, Pedicalopsis graminum *Reuter, first noted injuring plants on Long Island by R. H. Wolcott.*	
	Egg parasite, Œtetrastichus beatus *Perkins, introduced into Hawaii from Fiji to combat the sugar cane leafhopper.*	
	Tachina fly, Zygobothria nidicola *Townsend, parasite of the brown-tail moth, introduced into the United States from Europe.*	
	First specimens of Calosoma sycophanta *Linn., sent to United States from Italy by G. Leonardi.*	
	Proceedings of the Hawaiian Entomological Society begun.	
	W. G. Wright. Butterflies of the West Coast.	
	J. M. Aldrich. Catalogue of North American Diptera.	
	E. P. Felt. Insects affecting park and woodland trees. (Vol. II, 1906.)	
	J. G. Needham. Mayflies and midges of New York.	
	V. L. Kellogg. American insects. New York.	

BIRTHS	EVENTS	DEATHS
	R. Blanchard. Les moustiques. Histoire naturelle et médicale. Paris.	
	F. Schaudinn discovered the spirochæte of syphilis.	
	L. Rogers, in India, cultivated the Leishman bodies of Kala-azar.	
	J. E. Dutton, J. L. Todd, and H. H. R. Koch established the relation of ticks to African relapsing fever.	
	1906	
	Hop flea beetle, Psylliodes punctulata *Melsh., first observed on hops in British Columbia.*	*C. R. Osten Sacken (Russ.) 1828–1906*
	H. T. Ricketts proved that ticks transmitted the Rocky Mountain spotted fever.	*L. Fairmaire (Fr.) 1829–1906*
	Entomological Society of America organized.	
	British Columbia Entomological Society organized.	
	J. B. Smith. Glossary of entomology. Brooklyn.	
	J. W. Folsom. Entomology with special reference to its biological and economic aspects. Philadelphia.	
	Passage of the Adams Act to aid research in the Agricultural Experiment Stations.	
	San Francisco earthquake and fire, April 18.	
	Yosemite Valley and Mariposa Big Tree Grove accepted from California by United States.	
	1907	
	Citrus white fly, Dialeurodes citri *(R. & H.), discovered at Marysville, California.*	

Births	Events	Deaths
	Mediterranean fruit fly, Ceratitis capitata *Wied., probably introduced into Hawaii.*	
	Dryinid, Pseudogonatopus hospes *Perkins, introduced into Hawaii from China to prey upon the sugar cane leafhopper.*	
	F. M. Webster colonized Platygaster heimalis (*Forbes*) *on the Hessian fly in Maryland.*	
	F. P. Mackie discovered that the Asiatic relapsing fever was transmitted by the body louse.	
	F. H. Chittenden. Insects injurious to vegetables. New York.	
	N. Banks. Neuropteroid insects of the United States. Philadelphia.	
	T. D. A. Cockerell. Scale insects of the date palm.	
	V. L. Kellogg. Darwinism today.	
	E. G. Mitchell. Mosquito life. New York.	
	W. W. Froggatt. Australian insects. Sydney.	
	Pure food law became effective in the United States.	
	1908	
	Wadsworth bill, providing for a national quarantine law, again introduced into Congress—failed.	*W. H. Ashmead* (*U. S.*) *1855–1908*
	C. L. Marlatt prepared a new bill on National Quarantine—failed.	*W. G. Johnson* (*U. S.*) *1866–1908*
	Argentine ant, Iridomyrmex humilis (*Mayr*), *first recorded in California—quite abundant.*	*Alex. Craw* (*U. S.*) *1850–1908*
	Outbreak of California oak moth, Phryganidia californica *Pack., in the Santa Clara Valley.*	*James Fletcher* (*Can.*) *1852–1908*
	Hop flea beetle, Psylliodes punctulata *Melsh., a serious pest of hops in British Columbia.*	*G. L. Mayr* (*Aust.*) *1830–1908*

Births	Events	Deaths
	European ant, Myrmica levinodis *Nylander, found at Forest Hills, Mass., by W. M. Wheeler. September.*	*Paul Biolley (Costa Rica) 1862–1908*
	L. O. Howard received a shipment of Tetrastichus xanthomelænæ (*Rond.*), *parasite of the eggs of the elm leaf beetle, from Valery Mayet, Montpellier, France.*	
	Schedius kuvanæ *How., egg parasite of the gypsy moth, introduced into the United States from Japan.*	
	The F. H. Strecker collection of Lepidoptera purchased by the Field Museum of Natural History, Chicago.	
	Annals of the Entomological Society of America begun.	
	C. W. Woodworth. The Argentine ant in California.	
	N. Banks. Revision of the Ixodoidea or ticks of the United States.	
	V. L. Kellogg. Mallophaga in General Insectorum.	
	V. L. Kellogg. Insect stories.	
	H. Osborn. Economic zoölogy. New York.	
	W. A. Locy. Biology and its makers. New York.	
	Man of La Chapelle-aux-Saints found in Southwestern France.	

1909

Births	Events	Deaths
	Act approved March 13 provided for the extermination of rodents to reduce fleas as carriers of pneumonic plague in California.	*M. V. Slingerland (U. S.) 1864–1909* *W. H. Edwards (U. S.) 1822–1909*
	Citrus thrips, Scirtothrips citri (*Moult.*), *first recorded in California by D. Moulton.*	*G. Kraatz (Germ.) 1831–1909*

BIRTHS	EVENTS	DEATHS
	Gray citrus scale, Coccus pseudomagnoliarum *Kuw., discovered in southern part of California by E. O. Essig.*	*Anton Dohrn (Germ.) 1840–1909*
	S. W. Foster first noted the larvæ of the codling moth attacking walnuts near Concord, California.	
	Dictyospermum scale, Chrysomphalus dictyospermum (*Morg.*), *first reported in California by Bureau of Entomology, United States Department of Agriculture.*	
	Hayward Reed, Sacramento, first used surface pipe lines for orchard spraying in California.	
	Pomona College Journal of Entomology started at Claremont, California, by A. J. Cook and C. F. Baker.	
	American Association of Economic Entomologists replaced the Association of Economic Entomologists.	
	European earwig, Forficula auricularia *Linn., first noted in the United States.*	
	A. *D. Hopkins. Barkbeetles of the genus* Dendroctonus.	
	O. W. Œstlund. Outlines of entomology.	
	J. B. Smith. Insects of New Jersey. Trenton.	
	A. Berlese. Gli insetti.	
	H. Maxwell-Lefroy and F. M. Howlett. Indian insect life. Calcutta and Simla.	
	Wm. Bateson. Mendell's principles of heredity. Cambridge, England.	
	S. R. y Cajal. Histologie du système nerveux.	

Births	Events	Deaths
	A. Weismann. Die selektionstheorie. Jena.	
	F. K. Kleine proved that the sleeping sickness trypanosome undergoes a true development in the body of the tsetse fly.	
	C. N. Nicolle, H. T. Ricketts and R. M. Wilder, and J. Goldberger showed that typhus fever was transmitted by the body louse.	
	First commercial planting of about 1,500 acres of cotton in Imperial County, California.	
	A. D. Shamel, United States Department of Agriculture, began study of bud variation in citrus trees in California.	
	Alaska-Yukon-Pacific Exposition at Seattle.	
	R. E. Peary discovered the North Pole. April 6.	
	Sudan grass introduced into the United States.	
	1910	
	National Insecticide Act approved April 26.	*Cyrus Thomas (U. S.) 1825–1910*
	The grape mealybug, Pseudococcus maritimus *(Ehrh.), reported on fruit trees in Ventura County, California, by E. O. Essig.*	*Henry Ulke (U. S.) 1821–1910*
	Box leaf midge, Monarthropalpus buxi *Lab., first taken in the United States at Kingston, Long Island, by E. A. Stene in May.*	*H. H. Robt. Koch (Germ.) 1843–1910*
	European juniper webworm, Dichomeris marginellus *Fabr., taken at Tarrytown, New York, in February.*	
	Tachina parasite, Ceromasia sphenophori *Vill., of the sugar*	

BIRTHS	EVENTS	DEATHS
	cane borer, Rhabdocnemis obscura *(Bdv.), introduced into Hawaii from New Guinea by F. Muir and J. C. Kershaw.*	
	Mediterranean fruit fly discovered at Honolulu, Hawaii.	
	First International Congress of Entomology at Brussels.	
	D. W. Coquillett. Type species of North American Diptera.	
	T. L. Casey. First of the memoirs on Coleoptera.	
	L. O. Howard. Preventive and remedial work against mosquitoes.	
	W. S. Blatchley. Coleoptera of Indiana, Indianapolis.	
	W. M. Wheeler. Ants. New York.	
	N. Banks. Catalogue of nearctic spiders.	
	R. W. Doane. Insects and disease. New York.	
	C. W. Leng. Catalogue of the Coleoptera of North America, north of Mexico. Mount Vernon, New York. (Suppl., 1927.)	
	C. G. Hewitt. The house fly. Manchester, England.	
	Pomegranates grown commercially in California.	
	Rice culture started in California commercially.	
	1911	
	National Insecticide Act became effective January 1.	*H. C. McCook (U. S.) 1837–1911*
	A. J. Cook appointed California State Commissioner of Horticulture.	*S. H. Scudder (U. S.) 1837–1911*
	California Insecticide and Fungicide Law approved May 1, became effective July 1—adminis-	*D. W. Coquillett (U. S.) 1856–1911*

Births	Events	Deaths
	tered by the director of the State Agricultural Experiment Station.	*J. H. B. Bland* (*U.S.*) *1833–1911*
	Carpenter moth, Prionoxystus robiniæ (*Peck*), *noted injurious to oaks at Palo Alto by R. W. Doane.*	*F. C. Pratt* (*U. S.*) *1869–1911*
	Raspberry horntail, Hartigia cressoni (*Kirby*), *first noted in California as a pest of raspberries at Auburn, Placer County, by E. O. Essig.*	Francis Galton (Engl.) 1822–1911
	Eggs of European red mite, Paratetranychus pilosus *F. & H., first noted on apple in Oregon by H. E. Ewing.*	
	Garden nematode first noted in potatoes from Nevada.	
	Mediterranean fruit fly cleanup campaign begun in Honolulu.	
	Bathyplectes curculionis *Thompson, a parasite of the alfalfa weevil, was introduced into Utah from southern Europe by W. F. Fiske.*	
	Apanteles melanoscelus (*Ratz.*), *parasite of the gypsy moth, was introduced into the United States from Italy by W. F. Fiske.*	
	L. O. Howard. The importation into the United States of parasites of the gypsy moth and brown-tail moth.	
	L. O. Howard. The house fly. Disease carrier. New York.	
	The Monthly Bulletin, California State Commission of Horticulture. First number, Sacramento. December.	
	A. D. Hopkins. Contributions toward a monograph of bark-weevils of the genus Pissodes.	
	W. D. Hunter and W. A. Hooker. The North American fever tick.	

Births	Events	Deaths
	E. E. Austen. A handbook of the tsetse flies. London.	
	W. Reed, J. Carroll, W. C. Gorgas, etc., Yellow fever: a comparison of the various documents published.	
	W. E. Britton. Guide to the insects of Connecticut. Pt. I, Introduction. Hartford, Conn.	
	B. H. Walden. Guide to the insects of Connecticut. Pt. II, The Euplexoptera and Orthoptera of Connecticut. Hartford, Conn.	
	Bear flag adopted as the California State Flag. February 3.	
	A. D. Shamel, United States Department of Agriculture, began keeping performance records of citrus trees in California.	
	R. Amundsen discovered the south pole, December.	
	1912	
	National Quarantine Law approved, August 20.	*J. B. Smith (U. S.) 1858–1912*
	Federal Horticultural Board appointed in September.	*W. G. Wright (U. S.) 1830(?)–1912*
	First Federal Horticultural Quarantine Order No. 1, relating to white pine blister rust—September 16.	*J. S. Harbison (U. S.) 1826–1912*
	New California State quarantine law passed by a special session of the legislature in December, 1911, and approved January 2.	*P. Cameron (Engl.) 1847–1912*
	Hoplia dispar *Lec., reported as a pest of grapes in Madera County, California.*	*Sir Joseph Lister (Engl.) 1827–1912*
	Larvæ of range cranefly, Tipula simplex *Doane, first noted injurious to range grasses and alfalfa in the Sacramento Valley.*	*L. Ganglbauer (Germ.) 1856–1912*

Births	Events	Deaths
	Grasshopper invasion in the Imperial Valley.	
	Laurel psyllid, Trioza alacris *Flor., discovered in California at Oakland by D. L. Crawford.*	
	Pear thrips, Tæniothrips inconsequens (*Uzel*), *first noted in the Hudson River Valley, New York.*	
	European earwig, Forficula auricularia *Linn., noted at Buffalo, New York.*	
	Mediterranean fruit fly found on all the large islands of the Hawaiian group.	
	Second International Congress of Entomology held at Oxford, England.	
	L. O. Howard, H. G. Dyar, F. Knab. Mosquitoes of North and Central America and the West Indies. 4 vols.	
	J. B. Smith. Our insect friends and enemies. Philadelphia.	
	H. Skinner. One hundred years of entomology in the United States.	
	E. D. Sanderson and C. F. Jackson. Elementary entomology. Boston.	
	L. S. Daugherty and M. C. Daugherty. Principles of economic zoölogy. Philadelphia.	
	Bulletin Brooklyn Entomological Society again published.	
	L. C. Miall. The early naturalists. Their lives and work. London.	
	J. Loeb. The mechanistic conception of life. Chicago.	
	Dawn Man discovered in England.	
	California Raisin Growers' Association organized.	

BIRTHS	EVENTS	DEATHS
	Citrus Experiment Station established at Riverside, California.	
	1913	
	Second California State Board of Viticultural Commissioners created.	*P. R. Uhler* (*U. S.*) *1835–1913*
	California State Law provided for the extermination of rodents, insects, and other vermin liable to convey or spread contagious or infectious disease from an existing focus.	*L. E. Ricksecker* (*U. S.*) *1841–1913*
	Act approved June 7 provided for the extermination of insects affecting health in the same manner as those injurious to agriculture.	*J. J. Rivers* (*U. S.*) *1824–1913*
	E. O. Essig. Injurious and beneficial insects of California.	*A. G. Hammar* (*U. S.*) *1880–1913*
	Citrophilus mealybug, Pseudococcus gahani *Green, discovered at Ontario, California.*	*H. Jayne* (*U. S.*) *1859–1913*
	Pear thrips, Tæniothrips inconsequens (*Uzel*), *taken at Brooklyn, Md., by W. M. Scott. April 25.*	*M. E. Murtfeldt* (*U. S.*) *1848–1913*
	Fruit tree pulvinaria, Pulvinaria amygdali *Ckll., first noted in California on prune trees in Yolo County.*	*John Lubbock* (*Engl.*) *1834–1913*
	Cherry fruit sawfly, Hoplocampa cookei (*Clarke*), *first taken on cherries at Placerville, California, by E. O. Essig.*	A. R. Wallace (Engl.) 1823–1913
	G. P. Weldon first noted the pear leaf rust mite, Epitrimerus piri (*Napela*), *in California, on pears in San Diego County.*	
	R. K. Bishop reported the walnut scale, Aspidiotus juglans-regiæ *Comst., on English walnuts in Orange County, California.*	

BIRTHS	EVENTS	DEATHS
	Opius humilis *Silv.*, Galesus silvestrii *Kieffer and* Dirhinus giffardi *Silv., introduced into Hawaii from west Africa by F. Silvestri to prey upon the Mediterranean fruit fly.*	
	Diachasma tryoni *Cameron, introduced into Hawaii from New South Wales, Australia, by F. Silvestri to prey upon the Mediterranean fruit fly.*	
	American Association of Economic Entomologists incorporated, December 29.	
	Ximena McGlashan. The Butterfly Farmer, vol. 1. Truckee, California.	
	C. W. Woodworth. Guide to California insects. Berkeley.	
	Title of the Pomona College Journal of Entomology changed to the Journal of Entomology and Zoölogy.	
	H. G. Dyar started the Insecutor Inscitiæ Menstruus.	
	W. B. Herms. Malaria. Cause and control. New York.	
	E. D. Sanderson. Insect pests of farm, garden and orchard. New York.	
	W. J. Holland. The moth book. Garden City, New York.	
	W. D. Hunter. American interest in medical entomology.	
	G. S. Graham-Smith. Flies in relation to disease. Non-bloodsucking flies. Cambridge, England.	
	F. Silvestri erected the insect order Zoraptera.	
	V. E. Shelford. Animal communities in temperate America. Chicago.	

BIRTHS	EVENTS	DEATHS
	First farm advisor, A. Christiansen, appointed in California, in Humboldt County.	
	California passed Anti-Alien Land Law.	
	Parcel post established in the United States.	
	1914	
	Bulb fly, Merodon equestris *(Fabr.), reported at Berkeley by E. O. Essig.*	*C. S. Minot* (*U. S.*) *1852–1914*
	Lesser bulb fly, Eumerus strigatus *(Fallén), taken at Berkeley, Walnut Creek, and Oakland by W. M. Davidson.*	*D. E. Salmon* (*U. S.*) *1850–1914*
	Skinworm, Cacœcia franciscana *Wlshm. damage to apples first noted at Watsonville by A. W. Tate.*	*G. W. Peckham* (*U. S.*) *1845–1914*
	Larvæ of the codling moth found infesting green husks of the English walnuts at Carpinteria, California.	*J. B. Clemens* (*U. S.*) *1829–1914*
	Black scale conspicuous on olive trees at Marysville, California.	*Wm. Saunders* (*Can.*) *1835–1914*
	The grape mealybug, Pseudococcus martimus *(Ehrh.), became a pest of wine, raisin, and table grapes in the San Joaquin Valley.*	*Carl Fuchs* (*U. S.*) *1839–1914*
	R. E. Smith began making nicotine dust to control the walnut aphis, Chromaphis juglandicola *(Kalt.).*	*A. Weismann* (*Germ.*) *1834–1914*
	Pine moth, Evetria buoliana *Schiff., reported in Long Island, New York, by A. Busck. May.*	*C. Brunner von Wattenwyl* (*Aust.*) *1823–1914*
	Destructive pine sawfly, Diprion simile *Hartig, reported by W. E. Britton introduced into Connecticut from Europe. August 27.*	*Sven Lampa* (*Sw.*) *1839–1914*

Births	Events	Deaths
	Diachasma fullawaya *Silvestri and* Tetrastichus giffardianus *Silv., parasites of the Mediterranean fruit fly, introduced into Hawaii from West Africa by F. Silvestri.*	
	Acadian Entomological Society founded.	
	W. J. Holland. The butterfly book. Garden City, New York.	
	M. V. Slingerland and C. R. Crosby. Manual of fruit insects. Ithaca.	
	G. W. Herrick. Insects injurious to the household, etc. New York.	
	W. C. O'Kane. Injurious insects. New York.	
	E. Hindle. Flies in relation to disease. Blood-sucking flies. Cambridge, England.	
	T. B. Fletcher. Some South Indian insects. Madras.	
	Citrus canker discovered in Florida. May.	
	California Avocado Association organized.	
	330,000 acres of grapes in California (170,000 wine, 110,000 raisin, 50,000 table).	

1915

Births	Events	Deaths
	Act passed to prevent the spread of the date palm scales in California. April 2.	*J. T. Monell (U. S.) 1859–1915*
	Act relating to mosquito abatement districts in California approved May 29.	*H. M. Russell (U. S.) 1882–1915*
	California passed the apple grading law and fruit standardization act.	*L. von Heyden (Germ.) 1838–1915*
	Potato seed certification movement started in California.	*J. H. Farbe (Fr.) 1823–1915*

BIRTHS	EVENTS	DEATHS
	New orange pest, Platynota tinctana (*Walker*), *noted in southern California by R. S. Woglum.*	
	United States Post Office ordered terminal inspection of plants.	
	Mexican bean weevil, Spermophagus pectoralis *Sharp, noted at Pan-Pacific Exposition at San Francisco by E. O. Essig.*	
	The ladybird beetle, Delphastus catalinæ (*Horn*), *observed by E. J. Branigan to prey on the nymphs of white flies in southern California.*	
	Boxwood leafminer, Monarthropalpus buxi *Lab., first noted in California at Fresno on boxwood plants imported from England.*	
	A single living adult of Anomala rufocuprea *Mots., collected by E. O. Essig in Domoto Bros., greenhouse in Oakland, California, May 12. No other specimens seen since. Determined by E. A. Chapin in 1930.*	
	R. W. Doane called attention to losses caused by the wheat straw worm, Harmolita grandis (*Riley*), *in California.*	
	Dictyospermum scale Chrysomphalus dictyospermi *Morg., taken on Kentia palm in Ventura County, California, by A. A. Brock.*	
	C. W. Woodworth. School of fumigation.	
	V. L. Kellogg and R. W. Doane. Economic zoölogy. New York.	
	A. D. Hopkins. Preliminary classification of the super-family Scolytoidea.	
	N. Banks. The Acarina or	

Births	Events	Deaths
	C. L. Marlatt recommended sodium fluoride for the control of cockroaches.	
	J. A. Nelson. The embryology of the honeybee. Princeton, New Jersey.	
	W. A. Riley and O. A. Johannsen. Handbook of medical entomology. Ithaca, N. Y.	
	T. H. Morgan. The mechanism of Mendelian heredity.	
	Nature and science on the Pacific Coast. San Francisco.	
	11,372,500 peach trees in California.	
	H. Plotz discovered the typhus organism.	
	First use of the wireless telephone, United States to Honolulu.	
	1916	
	Citrophilus mealybug, Psuedococcus gahani *Green, first reported in the San Francisco Bay region by E. O. Essig.*	*A. J. Cook (U. S.) 1842–1916*
	Pear root aphis, Eriosoma languinosa *(Hartig), identified as distinct from the woolly apple aphis by A. C. Baker.*	*F. M. Webster (U. S.) 1849–1916*
	European earwig, Forficula auricularia *Linn., noted injurious at Seattle, Wash.*	*Theo. Pergande (U. S.) 1840–1916*
	Japanese beetle, Popillia japonica *Newm., discovered in New Jersey.*	*Otto Heidemann (U. S.) 1842–1916*
	Oriental peach moth, Laspeyresia molesta *Busck, discovered in the District of Columbia.*	*L. H. Joutel (U. S.) 1858–1916*
	Opius fletcheri *Silv., a parasite of the melon fly, was introduced into Hawaii from India by D. T. Fullaway.*	*E. B. Reed (Can.) 1837–1916*
	Œtetrastichus formosanus *Timb., egg parasite of the sugar*	

BIRTHS	EVENTS	DEATHS
	cane leafhopper, was introduced into Hawaii from Formosa.	
	Scolia manilæ *Ashm., a digger wasp, was introduced into Hawaii from the Philippine Islands, to prey upon grubs of* Anomala orientalis (*Waterh.*).	
	Tropical fowl mite, Liponyssus bursa (*Berlese*), *discovered in the United States.*	
	E. A. Gammon, Hood, California, installed the first permanent stationary spray pumping plant to control codling moth on pear trees in the state.	
	H. Osborn. Agricultural entomology. Philadelphia and New York.	
	W. S. Blatchley and C. W. Leng. Rhyncophora of Northeastern America.	
	J. M. Aldrich. Sarcophaga and allies in North America. Lafayette, Indiana.	
	J. G. Needham and J. T. Lloyd. The life of inland waters.	
	H. L. Viereck et al. Guide to the insects of Connecticut, pt. III, Hymenoptera, or wasp-like insects of Connecticut, Hartford, Conn.	
	Commercial production of lettuce on a large scale began in California.	

1917

BIRTHS	EVENTS	DEATHS
	Passage of Act to prevent the knowing introduction of living injurious insects through mails into California.	*W. D. Kearfott* (*U. S.*) *1864–1917*
	E. C. Van Dyke took the clover root curculio, Sitona hispidulus (*Fabr.*), *at Berkeley, California, May 2.*	*O. B. Johnson* (*U. S.*) *1848–1917*
		C. O. Waterhouse (*Engl.*) *1843–1917*

Births	Events	Deaths
	Hotel Sanitation Act, relating to the control of vermin or bedbugs in California, approved May 11.	
	Mediterranean fig scale, Lepidosaphes ficus (*Sign.*), *first noted in Fresno County by F. P. Roullard.*	
	Pink bollworm, Pectinophora gossypiella *Saunders, first discovered in Texas.*	
	European corn borer, Pyrausta nubilalis *Hbn., first discovered in United States near Boston by S. C. Vinal.*	
	Apple and thorn skeletonizer, Hemerophila pariana *Clerck, discovered at Irvington, New York, by E. P. Felt.*	
	E. P. Van Duzee. Catalogue of the Hemiptera. Berkeley.	
	E. P. Felt. Key to American insect galls.	
	Wm. Barnes and J. McDunnough. Check list of the Lepidoptera of Boreal America. Decatur, Illinois.	
	R. J. Tillyard. The biology of dragonflies. Cambridge, England.	
	United States declared war on Germany and entered the World War.	
	1918	
	First Federal Quarantine, No. 36, declared against the European corn borer, became effective only in Massachusetts, October 1.	*W. H. Patton* (*U. S.*) *1853–1918* *S. W. Williston* (*U. S.*) *1852–1918*
	First mosquito abatement district—Matadero District—organized in San Mateo and Santa Clara counties, California.	*Ellwood Cooper* (*U. S.*) *1829–1918*
	Broad bean weevil, Mylabris rufimanus (*Boh.*), *a serious pest*	*E. J. Vosler* (*U. S.*) *1890–1918*

BIRTHS	EVENTS	DEATHS
	of broad beans in San Mateo County, California.	*F. Knab (U. S.) 1865–1918*
	Outbreak of the Japanese mealy-bug, Pseudococcus krauhniae, *in the Ojai Valley, Ventura County, California.*	*H. O. Marsh (U. S.) 1885–1918*
	Metaphycus lounsburyi (*How.*), *introduced into California from Australia by E. J. Vosler and H. S. Smith.*	*W. H. Harrington (Can.) 1852–1918*
	White snail, Helix pisana *Lamarck, discovered at La Jolla, California, by C. R. Orcutt.*	
	Total expenditure for economic poisons, used for pest control in California, amounted to $2,652,-242.30.	
	J. G. Needham. Aquatic insects. In Ward and Whipple's Fresh Water Biology.	
	J. H. Comstock. The spider book. Ithaca, N. Y.	
	F. L. Washburn. Injurious insects and useful birds. Philadelphia.	
	J. S. Houser. Destructive insects affecting Ohio shade and forest trees. Columbus.	
	A. C. Chandler. Animal parasites and human disease. New York.	
	First larvæ of the vegetable weevil, Listroderes obliquus *Gyll., taken at Berkeley by H. H. P. Severin. The identity of the insect remained unknown as no adults were reared. First American record of this weevil*	

1919

BIRTHS	EVENTS	DEATHS
	Federal Quarantine No. 37—regulating the movement of plants and plant products, became effective June 1.	*M. E. Fernald (U. S.) 1839–1919*

Births	Events	Deaths
	California State Department of Agriculture organized with G. H. Hecke as director. July 22.	*H. H. Smith (U. S.) 1851–1919*
	Certification of seed potatoes act passed in California.	*F. H. Wooley Dod (Can.) 1870–1919*
	Act regulating shipping of grapevines for fuel passed in California.	*Lord Walsingham (Engl.) 1843–1919*
	Act, making an appropriation to determine and apply control measures to combat the spread of the codling moth in walnuts in California, approved May 27.	*F. D. Godman (Engl.) 1834–1919*
		E. H. Hæckel (Germ.) 1834–1919
	Western Plant Quarantine Board formed. May.	Theodore Roosevelt (U. S.) 1858–1919
	California Agricultural Legislative Committee formed at the State Fruit Growers' Convention at Chico.	
	Grape scale, Aspidiotus uvæ *Comst., reported on American grape at Oakland, California, by E. O. Essig.*	
	European apple sucker, Psyllia mali *Schmidberger, first recorded in North America at Wolfville, Nova Scotia.*	
	E. D. Ball discovered that potato tipburn was caused by the apple leafhopper, Empoasca mali *LeBaron.*	
	A. F. Swain. A synopsis of the Aphididæ of California. Berkeley.	
	European corn borer, Pyrausta nubilalis *Hbn., spread to Lake Erie region.*	
	Wm. Lochhead. Economic entomology. Philadelphia.	
	H. Noguchi isolated the yellow fever organism.	
	Eighteenth Amendment ratified.	

BIRTHS	EVENTS	DEATHS
	1920	
	Federal Quarantine No. 43, against European corn borer, became effective. March 29.	*Geo. Macloskie (U. S.) 1834–1920*
	Administration of the California Insecticide Law transferred from the director of the Agricultural Experiment Station to the State Horticultural Commissioner.	
	Division of Entomology, University of California, reorganized with W. B. Herms as head of the Division of Entomology and Parasitology.	
	Deciduous Fruit Station established in the Santa Clara Valley at Mountain View.	
	Rough strawberry weevil, Brachyrhinus rugosostriatus *(Gœze), discovered in a strawberry patch near Mt. Eden, Alameda County, and apparently eradicated by State Department of Agriculture in 1921.*	
	Specimens of the barnacle scale, Ceroplastes cirripediformis *Comst., taken on lemon tree at Ventura, California, by C. C. Staunton.*	
	Apple skinworm from Watsonville determined as Cacœcia franciscana *Walshm., by August Busck.*	
	Camphor scale, Pseudaonidia duplex *(Ckll.), first recognized as a pest in New Orleans.*	
	First specimens of the Asiatic beetle, Anomala orientalis *Waterhouse, taken at New Haven, Conn., by M. P. Zappe and B. H. Walden. July.*	
	Thurberia weevil, Anthonomus grandis *var.* thurberiæ *Pierce, noted as first attacking commer-*	

BIRTHS	EVENTS	DEATHS
	cial cotton near Tucson, Arizona, by A. W. Morrill.	
	Satin moth, Stilpnotia salicis *(Linn.), taken at Medford, Mass.*	
	European corn borer first discovered in Canada in Welland County, Ontario. August 10.	
	Bug, Cyrtorhinus mundulus *(Bredd.), predacious on eggs of the sugar cane leafhopper, introduced into Hawaii from Queensland and Fiji.*	
	Aphelinus mali (*Hald.*), *introduced into France by L. O. Howard.*	
	Mexican bean beetle, Epilachna corrupta *Muls., discovered in eastern United States.*	
	New oriental beetle, Pseudocneorrhinus setosus *Roelofs, discovered in Connecticut.*	
	L. O. Howard elected president of the American Association for the Advancement of Science.	
	J. H. Comstock. Introduction to entomology. First Part.	
	J. H. Comstock. The spider book. Garden City, New York.	
	W. S. Blatchley. Orthoptera of Northeastern America.	
	N. Banks and T. E. Snyder. A revision of the nearctic termites.	
	A. C. Maxson. Principal insect enemies of the sugar beet. Denver, Colorado.	
	G. W. Herrick. Insects of economic importance. New York.	
	W. E. Britton. Check-list of the insects of Connecticut. Hartford, Connecticut.	
	E. Holmgren. Textbook on histology (Swedish).	

BIRTHS	EVENTS	DEATHS
	150,000 acres of rice grown in California.	
	1921	
	California State Department of Agriculture organized.	*C. H. Fernald* (*U. S.*) *1838–1921*
	California Economic Poison Act approved June 3 and became effective August 2.	
	California State act providing for the collection and importation of parasitic and predacious insects from foreign countries approved June 3.	
	Mealybug act approved June 3 to prevent the spread of the grape mealybug, Pseudococcus maritimus (*Ehrh.*), *in California.*	
	Act to prevent the spread and to effect the control of codling moth of walnuts, June 3.	
	Revised fruit and vegetable standardization act passed.	
	California Standard Apple Act approved June 3.	
	Pure Seed Law approved May 3. California.	
	Border inspection for alfalfa weevil, Hypera postica (*Gyll.*), *inaugurated along the California-Nevada boundary.*	
	Grape mealybug, Pseudococcus maritimus *Ehrh., a pest of pears in the Santa Clara Valley, California.*	
	Water lily aphis, Rhopalosiphum nymphææ (*Linn.*), *noted on almond trees at Davis, California, by E. R. deOng.*	
	Ant, Monomorium destructor *Johnson, troublesome to passengers on steamers from Panama Canal Zone to California. Studied on shipboard by W. T. Clarke.*	

Births	Events	Deaths
	Bristly rose slug, Cladius isomerus *Norton, first observed at Alameda, California, by E. O. Essig. October 10.*	
	Squash beetle, Epilachna borealis *Fab., discovered near Douglas, Arizona, by W. W. Jones.*	
	T. J. Headlee first noted the oriental twilight beetle, Aserica castanea *Arrow, near Orange, New Jersey. (Reported as* Serica parallela.)	
	Insect pest survey reëstablished in the Bureau of Entomology.	
	H. T. Fernald. Applied entomology. New York.	
	A. D. MacGillivray. The Coccidæ. Urbana, Illinois.	
	E. F. Phillips. Beekeeping. New York.	
	W. D. Pierce. Sanitary entomology. Boston.	
	E. D. Sanderson and L. M. Peairs. Insect pests of farm, garden and orchard. New York.	
	F. R. Cole and A. L. Lovett. An annotated list of the Diptera of Oregon. San Francisco.	
	California Development Association incorporated. September.	
	California shipped nearly 8,000 carloads of lettuce east.	
	California shipped 15,000 carloads of cantaloupes east.	

1922

Births	Events	Deaths
	Artichoke plume moth, Platyptilia carduidactyla (*Riley*), *quite injurious to artichokes at Halfmoon Bay, California.*	*J. L. Hancock* (*U. S.*) *1864–1922*; *E. L. Graef* (*U. S.*) *1842-1922*
	Grape whitefly, Trialeurodes vittatus *Quaint., first reported*	*David Sharp* (*Engl.*) *1840–1922*

Births	Events	Deaths
	injurious to grapes at Ukiah by E. O. Essig.	*W. L. Distant (Engl.) 1845–1922*
	Vegetable weevil, Listroderes obliquus *Gyll., first noted in Mississippi.*	*Patrick Manson (Engl.) 1844–1922*
	Pseudaphycus utilis *Timb., introduced into Hawaii from Mexico to prey upon the avocado mealybug,* Pseudococcus nipæ *(Mask.).*	*Louis Bedel (Fr.) 1849–1922* *K. Kertesz (Hung.) 1867–1922*
	Colorado potato beetle discovered in Gironde, France.	
	Juniper webworm, Dichomeris marginellus *Fabr., noted at Los Angeles by A. G. Smith.*	
	Federal Horticultural Board visited California to confer on quarantine matters.	
	T. D. A. Cockerell. Zoölogy. Yonkers-on-Hudson, New York.	
	H. G. Dyar. The mosquitoes of the United States.	
	V. L. Kellogg. Human life as the biologist sees it.	
	R. G. Cleland. A history of California—American Period. New York.	
	W. E. Hardenburg. Mosquito eradication. New York.	
	E. Brumpt. Précis de parasitologie. Paris.	
	Lincoln Memorial at Washington, D. C., dedicated.	
	1923	
	Work of the State Insectary transferred from the California State Department of Agriculture to the University of California by Act of the State Legislature, and established at the Citrus Experiment Station, Riverside, July 1.	***E. A. Bischoff (U. S.) 1866–1923***

Births	Events	Deaths
	California State law providing for the control, eradication and destruction of forest insect pests, approved May 2.	
	Estimated loss to crops in California by insects, $26,651,900 by T. D. Urbahns.	
	Estimated amount spent for insect control in California, $10,706,100 by T. D. Urbahns.	
	Alfalfa weevil, Hypera postica *(Gyll.), entered Sierra County, California.*	
	First outbreak of the pepper weevil, Anthonomus eugenii *Cano, in southern California.*	
	European earwig, Forficula auricularia *Linn., first reported at Berkeley, California, by E. O. Essig. August.*	
	Snowy tree cricket, Œcanthus niveus *(DeGeer), first injured peaches in Sutter County.*	
	Arsenate of lead and nicotine proved as possible substitutes for lime-sulfur for control of peach twig borer by W. P. Duruz.	
	Potato tuber moth, Phthorimæa operculella *(Zell.), first noted in Maryland. December 20.*	
	W. M. Wheeler. Social life among the insects. New York.	
	A. D. MacGillivray. External insect-anatomy. Urbana, Illinois.	
	V. L. Kellogg. Mind and heredity.	
	W. T. M. Forbes. The Lepidoptera of New York and neighboring states. Ithaca, N. Y.	
	W. E. Britton. Guide to the insects of Connecticut. Pt. iv. The Hemiptera or sucking insects. Hartford, Conn.	

Births	Events	Deaths
	E. Martini. Lehrbuch der medizinischen entomology. Jena.	
	H. Maxwell Lefroy. Manual of entomology. London.	
	L. Abrams. *An illustrated flora of the Pacific States.* Vol. I. Stanford University, California.	
	First transcontinental air mail service in the United States.	
	First non-stop flight across the United States by Macready and Kelly in a Fokker airplane.	
	1924	
	Twelve border inspection stations established by California State Department of Agriculture along the border between California and Arizona and Nevada.	*A. D. MacGillivray (U. S.) 1868–1924* Jacques Loeb (U. S.) 1859–1924
	Elm leaf beetle, Galerucella luteola *(Müller), first discovered in California at Fresno, by F. P. Roullard. June.*	*A. Kœbele (Germ.) 1852–1924* *A. L. Lovett (U. S.) 1885–1924*
	Radish weevil, Ceutorhynchus rapæ *Gyll., reported in California at Campbell by R. D. Hartman. Previously listed in state by C. W. Leng, 1920.*	*W. A. Locy (U. S.) 1857–1924* *H. Champion (Engl.) 1869–1924* *Charles Oberthur (Fr.) 1845–1924*
	Pecan case bearer, Acrobasis indigenella *Zell., var.* nebulella *Riley, distributed in various parts of southern California on pecan trees. All trees later inspected in an extermination campaign.*	
	Diabrotica balteata *Lec., collected in Yuma, Arizona, April 3 and at Calipatria, California, April 4, by W. Benedict and A. C. Davis.*	
	Pan-Pacific Entomologist started at San Francisco.	

BIRTHS	EVENTS	DEATHS
	J. H. Comstock. Introduction to entomology. Ithaca. Complete.	
	E. P. Felt. Manual of tree and shrub insects. New York.	
	V. L. Kellogg. Evolution.	
	M. Meisel. A bibliography of American natural history. 3 vols. Brooklyn, 1924, 1926, 1929.	
	California Botanic Garden started at Sawtelle.	
	Beginning of the first foot and mouth disease epizoötic in California.	

1925

BIRTHS	EVENTS	DEATHS
	Lily thrips, Liothrips vaneeckei *Priesn., reported injurious to narcissus in California.*	*T. L. Casey (U. S.) 1857–1925*
	Leaf-footed plant bug, Leptoglossus zonatus (*Dallas*), *injurious to pomegranates and grapefruits in Imperial Valley, California.*	*H. A. Gossard (U. S.) 1868–1925*
	First adult of the vegetable weevil, Listoderes obliquus *Gyll., taken at Berkeley, California by F. C. Hadden.*	*W. D. Hunter (U. S.) 1875–1925*
	Thurberia weevil, Anthonomus grandis *Boh. var.* thurberia *Pierce, first known to attack cultivated cotton in Arizona.*	*Carlo Emery (It.) 1848–1925*
	Anagyrus dactylopii (*How.*), *introduced into Hawaii from China to prey upon the cottony mealybug,* Pseudococcus filamentosus (*Ckll.*).	*E. E. Bergroth (Finl.) 1857–1925*
	National Plant Board organized at Kansas City. December 31.	*G. B. Grassi (It.) 1854–1925*
	Third International Congress of Entomology held at Zurich, Switzerland.	*H. Maxwell Lefroy (Engl.) 1877–1925*

Births	Events	Deaths
	J. G. Needham and C. P. Claassen. Monograph of Plecoptera of North America. Lafayette, Indiana.	
	G. W. Herrick. Injurious insects. New York.	
	R. E. Snodgrass. Anatomy and physiology of the honeybee. New York.	
	H. M. Parshley. A bibliography of the North American Hemiptera-Heteroptera. Northampton, Mass.	
	A. D. Imms. A general textbook of entomology. London.	
	W. L. Jepson. A manual of the flowering plants of California. Berkeley, California.	
	1926	
	United States Bulb Quarantine became effective January 1.	*E. T. Cresson* (*U. S.*) *1838–1926*
	Thrips, Drepanothrips reuteri *Uzel, attacking grapes in Florin and Lodi Districts, California.*	*Henry Skinner* (*U. S.*) *1861–1926*
	Eggplant leaf miner, Phthorimæa glochinella (*Zeller*), *seriously injuring fruit of tomatoes in San Diego County, California.*	*R. H. Stretch* (*U. S.*) *1837–1926*
		J. C. Huguenin (*U. S.*) *1840–1926*
	Larvæ of vegetable weevil, Listoderes obliquus *Gyll., discovered at San José, California, by L. R. Cody. February 18.*	*B. P. Mann* (*U. S.*) *1848–1926*
	Pink bollworm found in Arizona.	
	Aserica castanea *Arrow, discovered at Mt. Vernon, New York.*	
	Ten million dollars appropriated by Congress to carry out cleanup campaign of the European corn borer in United States beginning in spring of 1927.	

Births | **Events** | **Deaths**

International Corn Borer Committee appointed.

Cost of foot and mouth disease epizoötic in California, $6,151,328.75—May 31.

E. O. Essig. Insects of Western North America. New York.

S. B. Freeborn. Mosquitoes of California. Berkeley.

S. B. Freeborn described the Clear Lake gnat as a new species, Chaoboris lacustris.

A. S. Pearse. *Animal ecology.* New York.

W. H. Wellhouse. How insects live. New York.

R. J. Tillyard. The insects of Australia and New Zealand. Sydney.

1927

California Act relating to the protection of Christmas berry and Christmas trees approved by the governor. May 2.

California Fruit, Nut and Vegetable Standardization Act became effective. August 1.

Strawberry root weevil, Brachyrhinus ovatus (*Linn.*), *found in Humboldt and Del Norte counties, California.*

Snowy tree cricket, Œcanthus niveus (*DeGeer*), *proved to be a serious pest of raspberries in San Mateo and Santa Clara counties, California.*

Citrus white fly, Dialeurodes citri (*R. & H.*), *again found at Oroville, California.*

Broad-nosed grain weevil, Caulophilus latinasus *Say, reported injuring avocado seeds and fruits in Orange County, California, by A. A. Brock.*

Deaths:

C. F. Baker (U. S.) 1872–1927

F. L. Washburn (U. S.) 1860–1927

Wm. Lochhead (Can.) 1864–1927

M. Bezzi (It.) 1868–1927

A. Berlese (It.) 1863–1927

BIRTHS	EVENTS	DEATHS
	Approximately 300,000 colonies of bees in California—estimated by the State Department of Agriculture.	
	Work begun on the ten-million dollar European corn borer clean-up campaign. March 21.	
	Mexican orange maggot, Anastrepha ludens (*Loew*), *discovered in Cameron and Hidalgo counties, Texas.*	
	The introduced cabbage weevil, Ceutorhynchus erysimi (*Fabr.*), *reported injuring seedling cabbage plants at Hartsdale, N. Y., by P. J. Chapman, June 22.*	
	Estimated acreage of major tree fruits in California: bearing 1,068,093 acres, non-bearing, 211,887 acres; grapes, 674,948 acres.	
	J. A. Comstock. Butterflies of California. Los Angeles.	
	P. Garman. Guide to the insects of Connecticut. Pt. V, The Odonata or dragonflies of Connecticut. Hartford, Connecticut.	
	Efforts made in thirteen states to pass anti-evolution statutes were unsuccessful.	
	The female sex hormone, or gland essence that causes typically feminine reactions and development in animals, was discovered in male and female animals by Otfried O. Fellner. Vienna.	
	Plague of mice in Kern County, California. January and February.	
	1928	
	Citrus white fly, Dialeurodes citri (*R. & H.*), *discovered at Arcadia, Los Angeles County, California.*	*Geo. Compere* (*U. S.*) *1858–1928*

Births	Events	Deaths
	Rough strawberry weevil, Brachyrhinus rugosostriatus *(Gœze), found on raspberries at Mountain View, by L. M. Smith (June) and on strawberries at Watsonville by F. L. Kellogg (May).*	*E. A. Schwarz (U. S.) 1844–1928*
	Coffee bean weevil, Aræcerus fasciculatus *(DeGeer), taken in a coffee warehouse in Los Angeles by A. C. Davis.*	
	Juniper webworm, Dichomeris marginellus *Fabr., again discovered and eradicated in Los Angeles, California, by H. J. Ryan.*	
	Elm leaf beetle, Galerucella luteola *(Müll.), found at Roseville, California. July.*	
	The cribrate weevil, Brachyrhinus cribricollis *(Gyll.), first noted at Montebello, California, by R. F. Haymaker, but not identified at the time.*	
	Fourth International Congress of Entomology held at Ithaca, New York.	
	C. L. Metcalf and W. P. Flint. Destructive and useful insects. New York.	
	L. O. Howard given honorary degree of Ph.D. by University of California. March 23.	
	J. G. Needham. Elementary lessons on insects. Springfield, Illinois.	
	J. G. Needham, S. W. Frost, and B. H. Tothill. Leaf-mining insects. Baltimore.	
	M. D. Leonard. A list of the insects of New York. Ithaca.	
	G. F. Ferris. The principles of systematic entomology. Stanford University, California.	

BIRTHS	EVENTS	DEATHS
	E. Nordenskiold. The history of biology. New York and London.	
	B. P. Uvarov. Locusts and grasshoppers. London.	
	1929	
	Term County Horticultural Commissioner changed to County Agricultural Commissioner by act of California State Legislature.	*H. G. Dyar (U. S.) 1866–1929*
	Transverse poplar gall aphis, Pemphigus populitransversus *Riley, serious pest on roots of lettuce in Santa Cruz and Monterey counties. Noted by E. O. Essig.*	*F. H. Chittenden (U. S.) 1858–1929*
	Infestation of the peach borer, Ægeria exitiosa *Say, discovered in a nursery at Compton, California, by H. J. Ryan and eradicated.*	*W. T. Clarke (U. S.) 1863–1929*
	Citrophilus mealybug, Pseudococcus gahani *Green, infested pears in the Carmel Valley, California.*	*C. R. Orcutt (U. S.) 1864–1929*
	Nitidulid beetle, Epuræa luteola *(Er.), reared from orange fruit taken in the market at San Francisco by E. O. Essig.*	
	Bristly rose slug, Cladius isomerus *Norton, abundant and destructive throughout the San Francisco Bay region, California.*	
	The cribrate weevil, Brachyrhinus cribricollis *(Gyll.), again taken at Montebello, California, by A. Toyne, and determined by L. L. Buchanan.*	
	Second outbreak of foot and mouth disease in California, at Whittier. January. Quickly eradicated.	

Births	Events	Deaths
	Larvæ of the Mediterranean fruit fly, Ceratitis capitata *Wied.*, *discovered in grapefruit in Florida, April 6.*	
	Larvæ of Mediterranean fruit fly, taken in Florida, determined by C. T. Green. April 10.	
	First Federal Notice of Quarantine No. 66, relating to the Mediterranean fruit fly in Florida, issued April 26.	
	J. G. Needham and H. B. Heywood. A handbook of the dragonflies of North America. Springfield, Illinois.	
	H. E. Ewing. A manual of external parasites. Springfield, Illinois.	
	R. A. Wardle. The problems of applied entomology. New York.	
	A. F. Mason. Spraying, dusting and fumigating of plants. New York.	
	R. Matheson. A handbook of the mosquitoes of North America. Springfield and Baltimore.	
	V. E. Shelford. Laboratory and field ecology. Baltimore.	
	S. A. Graham. Principles of forest entomology. New York.	
	E. C. Faust. Human helminthology Philadelphia.	

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